THE ENGINEERING MAGAZINE

THE WORLD IS ITS FIELD

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# THE BUILDING OF A CHINESE RAILWAY.

*By Justin Burns.*

An article by Mr. Thos. H. Reid on "Railway Making in China," which we published in December, 1903, dealt chiefly with the economic side of the development and the general features of the projected enterprises. The account by Mr. Burns, which we now present, is concerned with the practical work of carrying out the construction, and has the peculiar interest which attaches to a record by one who has been in actual charge of the building of the line and the handling of the novel problems presented by the country and the people.—THE EDITORS.

CHINESE SOLDIERS.

THE material development of internal resources and communications in China followed the war with Japan in 1895. Within the preceding quarter of a century, railroad construction had made a beginning, yet there were only a few miles of line in operation; telegraph systems were fairly well established, connecting the important provinces; but it was not until after being thoroughly defeated by Japan that China awakened to the possibility of the presence of some element of weakness in her organization. The self-glorification and self-satisfaction had been so intense in the previous years that she was blind to all things outside the walls of the Celestial Kingdom; but when she discovered her inability to

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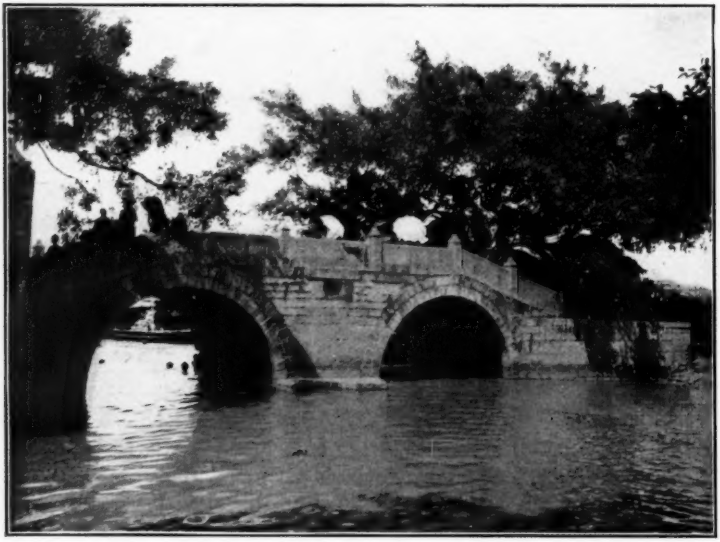
move or concentrate her troops or to replenish stores from distant provinces, the immense advantages of communication by railroad began to dawn upon the minds of the officials. It was then that the first real impetus was given to the construction of railroads in China. At that time, the only ones in existence were the few miles of track from Shanghai to Woosung and the few hundred miles from Tientsin to Manchuria. Peking was still isolated, the communication being only by cart or junk.

For the improvement of internal conditions, departments of railways were established; but on account of the drain upon the resources at that period it was necessary to depend upon foreign capital to develop this most important element in the future welfare of the Empire. For various reasons of favor or influence, concessions for railroads connecting principal cities and provinces were given to different nationalities. A small amount of work was attempted by the Imperial Chinese Railway Administration without the aid of foreign capital, but this construction could not be otherwise than slow and inferior. The foreign railway influence caused by the distribution of concessions could be generalized by stating that the Russian was dominant in the north beyond Peking; the German in the northeast

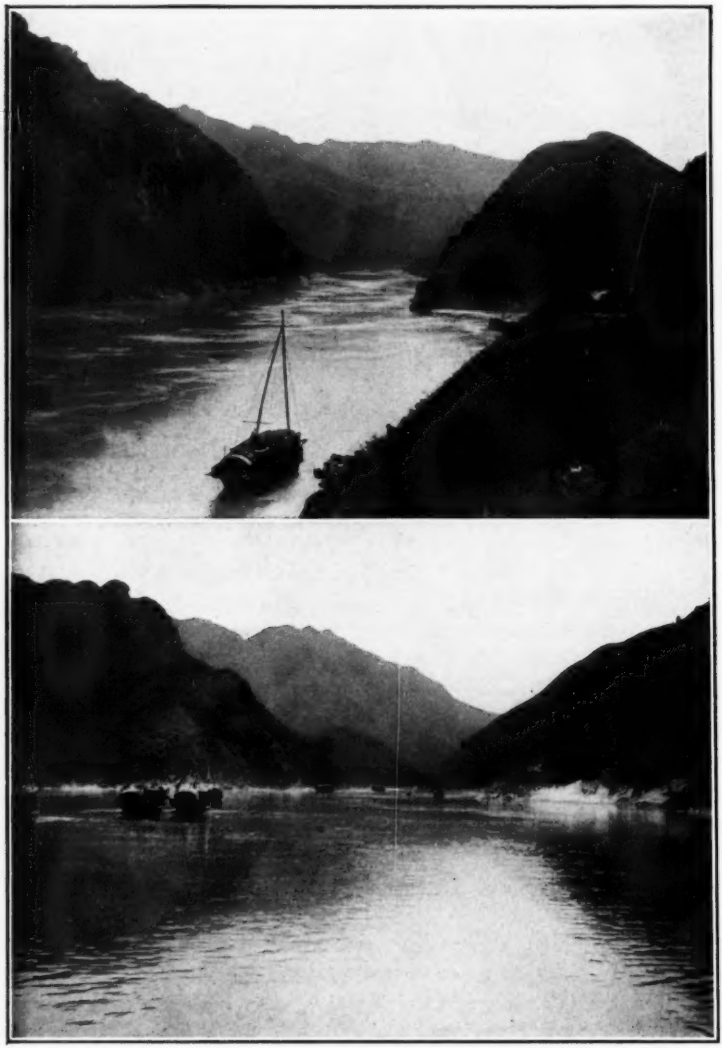


A NATIVE CHINESE BRIDGE. SHOWING THE USE OF THE ARCH.

AN ILLUSTRATION OF THE COUNTRY ON THE SOUTHERN END OF THE CANTON HANKOW LINE. INUNDATED RICE FIELDS, SHOWING GRAVES IN THE BACKGROUND.

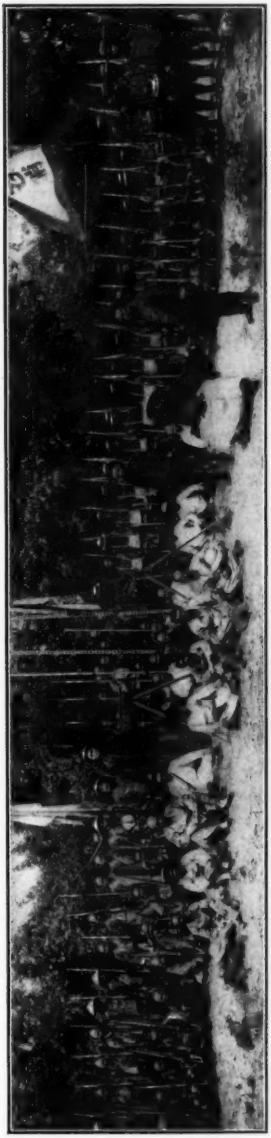
in the Shan Tung Peninsula; the British in the middle east adjacent to Shanghai; the French in the isolated southwest; the Belgian in the north middle, southward from Peking; and the American in the south middle, northward from Canton. Of the many concessions, it is generally admitted that the line from Canton to Hankow is one of the most valuable, on account both of its traversing provinces rich in mineral wealth and agricultural products, and of its forming a most important link in the vast continental system which will connect the eastern with the western world.

The American concession granted to the American China Development Company, is known as the Canton-Hankow Railway (Yueh-Han) which will connect the above named cities by a railroad of about seven-hundred miles in length. The line, whose general direction is almost due north, passes from Canton northerly along the east bank of the Pearl River across the low divide to the east bank of the North River (Pak Kong) which it follows for about two-hundred miles; the railway crosses the Chi Ling range of mountains into the valley of the Yang Tse Kiang, on the east bank of the Siang River, and follows this stream till near the Yang Tse where it bears off slightly to the eastward, following the right bank of that river to Hankow. Included with the concessions for the main line from



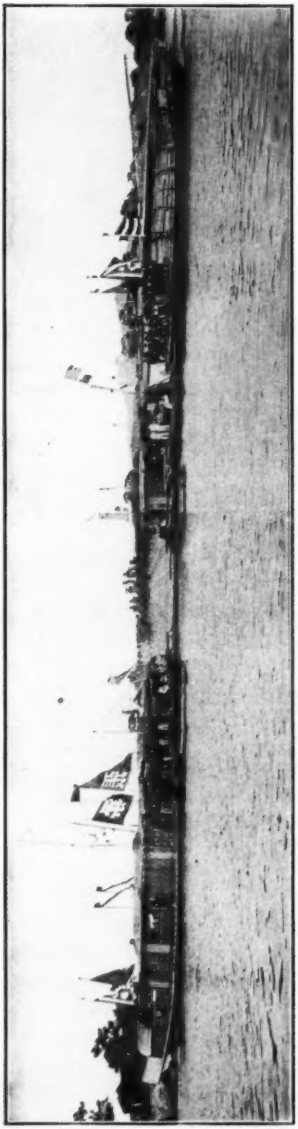
ON THE NORTHERN END OF THE LINE. VIEWS ON THE PAK KONG OR NORTH RIVER.

Canton to Hankow is the grant to construct a short line westward from Canton for a distance of thirty miles, establishing rail communication between the treaty ports of Sam Shui and Canton.



A LOCATING PARTY. AMERICAN ENGINEERS, CHINESE MANDARINS, ASSISTANTS, AND GUARDS.

The preliminary steps toward actual construction were taken in March, 1902, by the arrival in China of the officials of the American China Development Company. The location surveys were begun that fall, but ground was not broken for construction until March, 1903. To Americans who are accustomed to the rapid completion of railroad construction this delay in the actual commencement of the turning of earth into embankments seems inexplicable, but it is ignorance of the conditions that exist in the strange country of China which prevents the proper conception of the difficulties and obstacles encountered. The mere fact that the government at Peking grants permission for a foreign company to engage in an enterprise protected and vouched for by the Chinese Emperor is a simple factor in the problem. The difficulties in satisfying the crown appointees in charge of internal communications, the viceroys of the provinces, the lessor officials of controlling influence, do not appeal to a westerner until he has spent his weary weeks or months awaiting the confirmation of the already given approval. The consent, the influence, the assistance (passive or active) of the officials are obtained in various ways. The engineer who combines with his technical qualifications those of the diplomatic service will find need of every resource to make a success of the Oriental enterprise entrusted in his charge. The friendship of the local officials of the province or district is essential for



A LOCATING PARTY ESTABLISHED IN HOUSEBOATS.

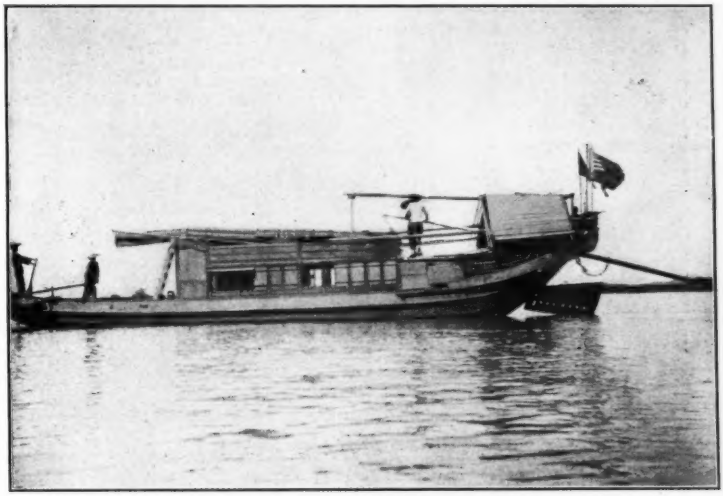
the successful prosecution of the work, and it needs but the reminder of the difficulties which beset the first telegraph company, which had concessions for the erection of their line through Fukien and the southern provinces, to recall the influence of the mandarins in ordaining the success or failure of the enterprise.

Before actual surveys were commenced in Kwang Tung it was necessary to obtain the official sanction and approval of the Viceroy to proceed with this work. This official action, after the customary Oriental delay, appeared in the form of a proclamation, setting forth the good intentions of the foreigners in constructing a railroad which would confer untold benefits upon the Empire and its inhabitants, admonishing the natives to restrain from opposition to the work, and urging them to render all possible assistance to the engineers. Copies of this proclamation were posted throughout the villages adjacent to the projected railroad. A copy was painted on a large board frame and carried in advance of the surveying party, so that the natives along the line of survey could be fully informed as to the nature of the work and the proper authority for allowing the foreigners to proceed without molestation.

In the surveys for the Canton-Hankow Railway, the engineers were, in the main, Americans, with the assistance of a few Chinese and several Japanese engineers. The

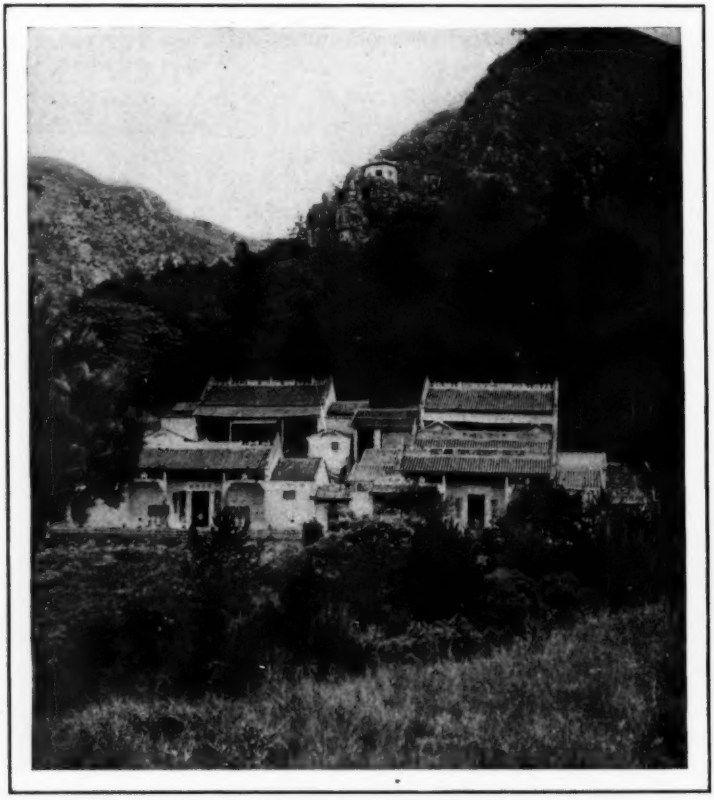
minor positions in the field parties, such as chainman and rodman, were quickly filled by Chinese who soon satisfactorily learned their duties. Concerning the efficiency of these Oriental engineers, not much that is laudatory could be said of the Japanese, and much less of the Chinese engineers who were educated in the technical colleges of North China. The Oriental engineers who were educated in America ranked well in ability, and it would seem that the Chinese, with proclivities for technical study and with a training in efficient engineering colleges, would make successful, competent engineers, who could in time carry on the management and the construction of the public improvements which might be commenced by foreigners.

The country throughout Kwang Tung is so intersected by water-



THE HOUSEBOAT OF A LOCATING ENGINEER.

ways that the field parties, during both the surveys and the construction, usually lived in houseboats, which as the work progressed could be moved along the various streams to a locality adjacent to the line. The houseboats proved to be most satisfactory, since they afforded dry, sanitary habitations, isolated from the crowds of the curious, and separated from the vicinity of the filth and contagion of the village houses. These commodious boats provided room for the transportation of personal effects, and of field and office equipment which could not have been taken if the field party had been compelled to transport its belongings overland from camp to camp. Houseboats have



TEMPLES, TYPIFYING THE RESIDENCES USED BY THE ENGINEERS OF THE RAILWAY SURVEY.

been utilized for the head-quarters of the surveying parties for a hundred and thirty miles into the interior, excepting for a distance of thirty miles across the divide from the Pearl to the North River.

When working in the interior, remote from the streams, the field party made its head-quarters in some temple which was rented for a nominal figure from the village elders. This structure has not the sacredness which we usually associate with the name "temple," and a more appropriate designation might be ascribed to the edifice by calling it a town hall. In these Chinese villages where no hotels or lodging houses exist, some building must be set aside for the use of visiting

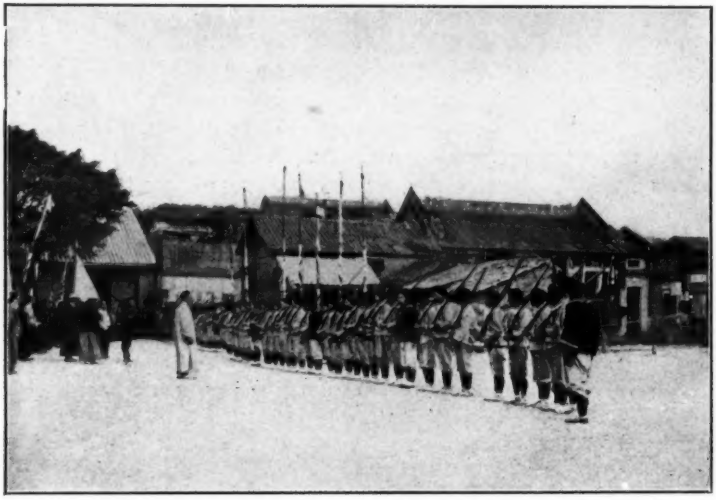
officials or strangers; it is therefore the custom to place these temples at the disposal of the visitor, who works, cooks, eats, sleeps within the sacred walls, without the slightest offence to the gods or the ancestors who were commemorated by that edifice.

In the matter of subsistence, the foreign engineers lived in the manner customary to western civilization. No difficulty was experienced in fitting out the field parties with native cooks, who had been taught western cooking either in the foreign concessions or in foreign countries, or in the warships of the foreign nations in the Oriental waters. The Chinese markets provided fresh meats and fresh vegetables, but in the interior canned goods were largely used. On account of the methods of Chinese garden cultivation, no vegetables were eaten uncooked, even though the native gardeners raised in profusion all delicacies of both the western and eastern worlds. No water was drunk unboiled or unfiltered. The Chinese servants could not be trusted to prepare the drinking water, excepting directly under the visual supervision of the chiefs of parties or a member of the medical corps. The extreme care taken with the drinking water kept the water diseases at a low percentage. The general health of the corps

SHIFTING CAMP IN THE INTERIOR.

in this humid tropical climate was excellent, but this was largely due to the thoroughly efficient medical staff which forms such an important department in enterprises operating beyond the pale of civilization.

In the concession from the Chinese Government there was a provision which guaranteed the protection of the lives and property of the foreigners engaged in this railway enterprise. Authority was given



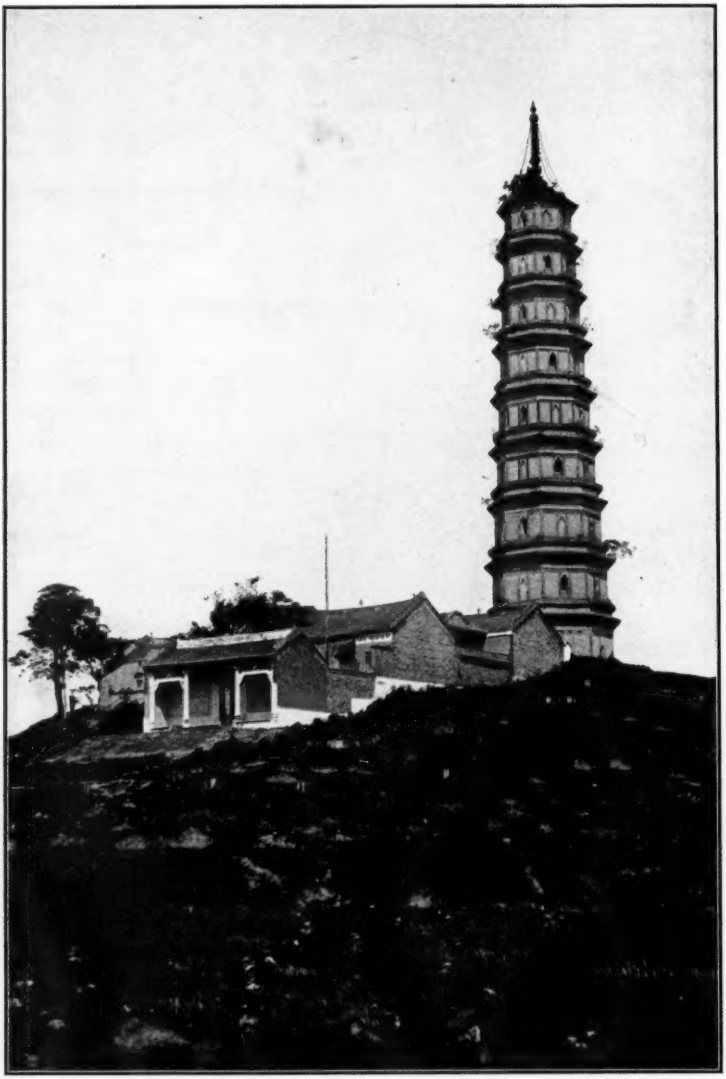
INSPECTION OF THE VICEROY'S SOLDIERS AT WONG SHA.

to the railroad company to enlist regiments of native soldiers to serve as railway guards. In addition to these guards, other soldiers when needed were furnished by the viceroys of the provinces or the magistrates of the districts in which the work was being done. The use of soldiers with the surveying parties was twofold; the one purpose was that of protection, the other was that of display. As a matter of protection, the numerous instances of disturbances and riots proved the Chinese soldiers wanting in the qualities which we usually ascribe to military men. Considering the methods of recruiting these regiments one cannot expect much from the ordinary Chinese soldier. He is usually a low-grade coolie, inefficient as either a laborer or a thief; he is placed in a uniform marked on the breast and on the back with the inscription denoting the province, district, or company to which he is attached; he is poorly armed with a gun or a revolver badly copied from some European model. There does not seem to be any obligation or penalty in the enlistment, so that when the conditions have become

CAPTAINS OF THE RAILWAY GUARD.

unsatisfactory, the soldier can leave the service by taking off his coat. The only inducements which cause him to remain faithful are his monthly salary and his freedom from work.

Just previous to the beginning of the surveys in any locality, the locating engineer, together with the interpreters, mandarins, and escort of soldiers, makes a formal call upon the magistrate of the town or district in which the surveys are to be made. The official call not only gives the surveying project the stamp of official approval, but being in keeping with the strict Chinese etiquette it often serves to



A TYPICAL CHINESE HILLSIDE, THICKLY SET WITH GRAVES.

The graves are marked by fluttering strips of paper, held down by clods of earth. Once a year, in the spring, these strips are renewed by visiting friends, with the setting off of firecrackers and other ceremonies.

obtain the good will of the officials and prevents the secret inciting of opposition. It has always been necessary to pay the greatest respect to the officials and elders of the various villages along the line, and wherever it has been possible to obtain their good will, the difficulties of the work have been greatly diminished. The field parties are accompanied by mandarins of a low rank who are thoroughly conversant with the nature and needs of the railroad work, and who can take charge of the soldiers and affairs outside of engineering, such as adjusting the payments for crops or trees which might have been destroyed in making the surveys. The efficiency of these accompanying mandarins is a controlling element in the success of the field party.

Taken as a whole, there has not been great opposition by the natives to this railroad work. Riots and disturbances have arisen at times which were aimed against the surveys or the construction. The enmity of the great mass of Chinese to the introduction of any method of accomplishing results differently from their ancestors has caused the ignorant and the superstitious occasionally to offer armed opposition to the progress of the work. The engineering corps has been fortunate in these affairs so that no serious results have occurred. Prompt and sincere assistance on the part of the Chinese officials can always convince the rioting populace of the error of their actions and their misdirected efforts in the destruction of the "foreign devils."

When the locating engineer selected his line, it was the general practice to please the natives so far as possible and yet lay down a road economical in future construction and operation. The natives would request the avoidance of the proximity of the line to villages, to graves, to temples, to certain trees or certain hills as the case may be. To the villager the location of the railroad near his home meant no increase of business, but only a loss of arable land. The destruction of the graves or temples meant probable future disaster to the community. Throughout Kwang Tung nearly every hill is utilized as a graveyard, and in the more populous districts it is impossible to project a suitable line which would not intersect these cemeteries. In passing through these hills, care was taken to avoid disturbing the more important graves as designated by sunken masonry monuments. Yet little trouble was finally experienced when it became absolutely necessary to excavate where the graves were located. It was merely a matter of paying the price, which after considerable haggling was generally reduced to a low figure.

One of the strongest features in opposition to the railway line was the cutting through certain hills which had been held in sacred awe

by the villagers. It was only with the greatest reluctance that the villagers would allow these hills to be cut, and in fact, in some cases, it was necessary to shift the line in order to appease these superstitious beliefs. This opposition is due to the peculiar superstition of the Chinese concerning "Fung-Shui" (literally, wind and water; liberally, the gods of wind and water.) The superstitious belief in the power of the "gods of wind and water," more than any thing else, has prevented the opening up of mines throughout southern China where the country is so rich in mineral wealth.

Considerable trouble was experienced in preserving the stakes which were placed on the surveyed line. For many months, different methods of threats and entreaties were employed to compel the natives to leave the stakes where the engineers had placed them; but wood is too valuable in China to be left around loose, and so the stakes gradually disappeared. It finally became the practice of the locating parties to make the surveys as free as possible of any stakes remaining in the ground after the advance of the survey. The important transit points were well referenced to natural objects, and the stakes marking these points were deeply buried so that at a future date when construction began, these buried stakes could be relocated and the necessary intermediate stakes placed by the resident engineer.

After the location surveys had been completed, the next step toward construction was the right-of-way surveys and the purchasing of lands. These surveys, with the field work and drafting, proved more expensive than those of reconnoisance and location. The farms of the Chinese are very small, the separate rice fields much resembling our garden plots. The property lines run in all directions, yet it was necessary for the field party to stake out each plot so as to designate accurately the land to be purchased for the railroad. The Chinese land owners have been particular to mark their various fields, and a hasty glance at the numerous inscribed granite monuments protruding above the surface of the ground would lead one to suppose that the land was carefully laid out and defined. As a matter of fact, these stones are placed not on the corners or on the side lines of the field, but approximately in the centre, with no reference whatever to the limitation of the area. Usually the distinction between owners was made by a small dike, but yet many fields belonged to many separate owners without the slightest mark designating the dividing line of the different farms, so that the proper boundaries became matters of arbitration among the land owner, his village elders, and the railroad deputy mandarin accompanying the party to adjust such affairs.

When the property maps were completed, they contained the names of the owners, the numbers of lots, and the areas of the ground, in Chinese characters, so that the property owners and the Chinese Railway Land Department could understand the map without the aid of an interpreter. The Chinese unit of land, called in Cantonese a "mou," contains six-thousand square Chinese feet. Unfortunately, the length of a Chinese foot varies throughout the Empire, so that the area of a mou is considerably different in the various provinces of China; in Canton, the unit area so closely approximated a fifth of an English acre that this ratio was chosen for converting the acres into Chinese measure.

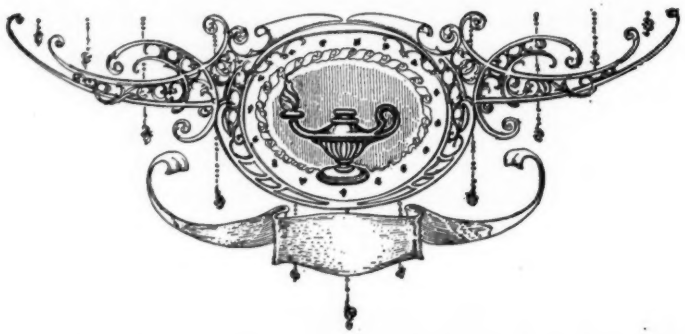
A CHINESE SURVEYOR, WITH HIS INSTRUMENTS AND PARTY, IN THE FIELD.
The attendant on the left, with the rod, carries the abacus. The surveyor holds the large dividers—the sole measuring instrument—with which the lines are stepped off.

For the actual transactions in the purchasing of lands and the clerical work on the deeds, the Railway Company established a land department in which Chinese officials had entire control, excepting that the engineer in charge of the work conferred with the purchasing mandarin regarding the unit price paid for land. This would prevent any unscrupulous officials from advancing the price beyond a reason-

able figure, although ultimately the Imperial Government would pay for all lands purchased.

Before proceeding with the purchase of lands, it was necessary to employ Chinese surveyors to demonstrate to the land owners that no error in measurement had been made by the foreigners. These native surveyors, with the right-of-way maps of the railway engineers, would locate the various plots of ground and mark out the exterior by stretching a string around the boundaries of the lots to be measured. Then taking large wooden dividers between whose point were exactly five Chinese feet, the surveyor proceeded to step this spacer around the exterior of the plot. This measuring was done in a rapid manner, the result carefully tabulated in field books, and the areas immediately calculated upon the abacus. It was never thoroughly understood by us engineers how the Chinese so quickly measured and computed these areas, since it had taken the foreign engineers days to perform the same work done by Chinese in hours. It is interesting to add that the Chinese always checked the maps exactly.

Contrary to expectations, the land owners allowed the railroad construction to be begun in their fields not only before the land was paid for, but before the price was agreed upon. The natives seemed to have faith in the fairness of the Chinese officials in charge of the Land Department, and in the foreign engineers, that a just price would be paid for the land. This allowed the commencement of the work sooner than anticipated, but it had the disadvantage of allowing the procrastinating Chinese to dally with the land purchases so as finally to exasperate even the limit of Chinese patience and cause trouble on the main line in the following year.



# STORES ARRANGEMENT AS A FACTOR IN SHOP MANAGEMENT.

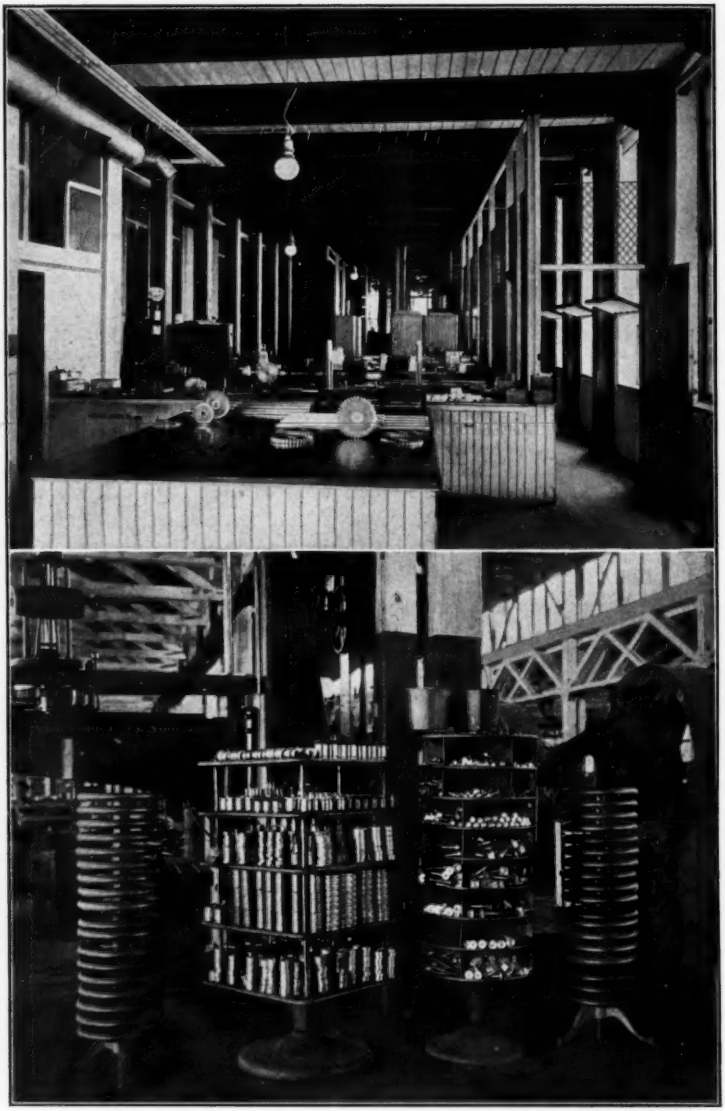
*By John Ashford.*

## II.—The Details of a System Carried Out.

In introducing Mr. Ashford's first article, in our preceding issue, we referred to the interest which the discussion of stores-room practice carries, by virtue of the relative backwardness of this department in many otherwise well organised shops. This interest appears so keen, on further pursuit of the theme, that we have arranged to follow Mr. Ashford's exposition in this number of a definite system, by a series of papers, describing in detail and with full illustration the methods of some of the foremost and most modernised shops.—THE EDITORS.

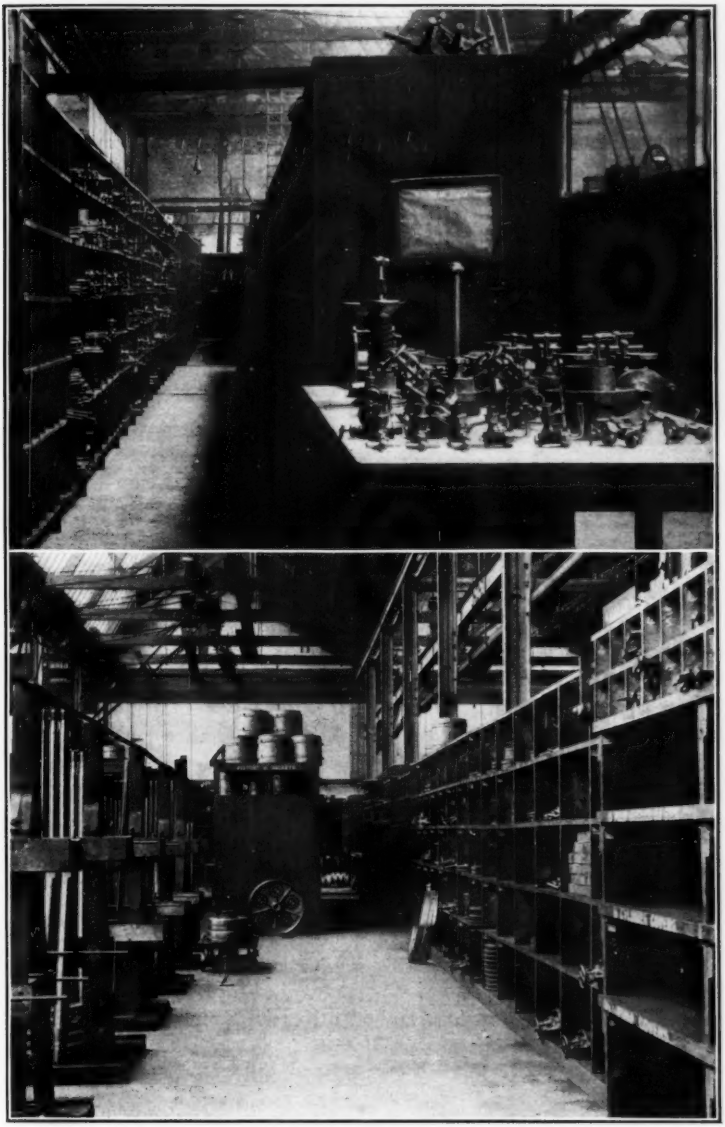
THERE are of course various ways of ordering work from the shops; in some places each detail is ordered, and in others the orders are very broad, much being left for the men to find out afterwards from the drawings or by enquiry. In some factories the card system of ordering and costing is worked with great ease, while in others all orders are written on sheets and costing is independently looked after.

In any arrangement of ordering and costing there are four things to be observed—firstly, it must occasion as little interruption to work and delay in the shops as possible; secondly, it must work smoothly; thirdly, it must give accurate results, and fourthly, it must not be clumsy or costly in itself. Of these four things that should be observed the first and fourth are often wrongly valued. A system may be called cheap because it takes few clerks to work it, and yet it may be very expensive in delays to the men in the works, whereas another, using more clerks, and appearing to be more costly, is yet the cheaper in reality. It must be remembered that the men must get particulars of their work from some source, and it is decidedly cheaper for it to go to them than for them to fetch it or seek it. Further, time has to be booked for cost-keeping purposes, and it is a costly matter for the workmen to do it all themselves. The men are generally slow at clerical work—at any rate, much slower than a clerk, and they individually would take at least twice as long as a clerk to do a given amount of writing. Their rate of wages, moreover, is generally much greater than the clerks'; thus all writing done by a mechanic will cost the firm about four times as much as if done by a clerk. Writing has usually



STORES ARRANGEMENTS IN SOME OF THE WORKS OF THE NILES-BEMENT-POND COMPANY.

Above is the shipping and stores room of the Pratt & Whitney Works. All tools, after final inspection, are delivered to this room and prepared here for shipment. Below is a section of the stores department in the Pond Works; the racks for holding various parts of machines are fitted with ball bearings, so that any part desired may be easily obtained by turning the stand around. The system is very advantageous where space is limited.



SECTIONS OF THE STORES DEPARTMENT, MESSRS. G. & J. WEIR, LTD., CATHCART, GLASGOW.

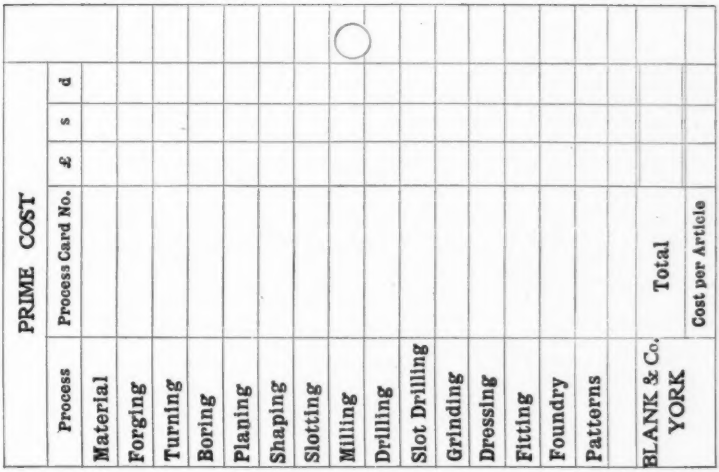
The upper view shows the storage of finished material in the brass stores. The lower is the main finished-goods department. Upright racks for pump rods are seen on the left; pigeon holes for valves, springs, covers, etc., are shown on the right and at the rear.

to be done in several directions, i. e., the writing of orders by the order department, the writing of contracts by the piece-work or premium clerks, the booking of the men's time for each operation, and, where books are used for costing, the posting of items from time sheets to cost books. Thus if a job has five operations upon it, before it is finished it will be referred to in writing no less than eight or nine times, of which five will be by mechanics if the men book their own time on sheets. Let us consider now a method of fusing these various writings together with a view to reducing the total of it and giving all information directly to the man who needs it. From the specification upon which the draughtsman has put the drawing numbers, the order department would prepare a series of order cards, one for each item not in stock that must be manufactured. These order cards would be numbered in sequence, and when written their numbers are entered in the order card number column on the specification of details. This is to tell the cost office what order cards have been issued. The arrangement of these cards will vary according to the factory where they are used, but may be like the illustration on the opposite page.

On the front of the card is its own number, the identification number or symbol, and blank places for filling in other information. The reverse has a list of machining operations with space for cash and process-card numbers. The order cards are first passed to the works office, which is immediately associated with the works manager and is the place where machining processes, tools, and other works matters are arranged, there to have tick marks placed against the processes the articles must undergo; the cards are then returned to the order clerk. He then prepares a process card for each process the work must undergo, and this process card will serve the purpose of shop order, contract for piece-work, identification note to inspectors and stores keeper, and finally as time card to supply information to the cost office.

A process card used in conjunction with Rochester recorders is illustrated on page 183.

The card will be seen to give particulars of the work, the process it is for, the drawing number, and identification symbol, on one face; upon the other there is space for the man's name and number (which is filled in by the foreman), order-card number for posting purposes when it reaches the cost office, and a place for the inspector's initials. The card will thus be seen to contain all information the man needs to identify the work and secure the correct drawing. To facilitate identification, the schedule number or symbol explained last month can be used as a pattern number, which should be clearly impressed in the




REVERSE OF THE ORDER TICKET.

Identification No. _____ Order Card No. 44253

Machine or Stock No. _____ Progressive Order No. _____

Description _____

Material _____ Drawing No. _____ Pattern No. _____

Weight in the Rough: tons _____ cwt. _____ qr. _____ lbs. _____

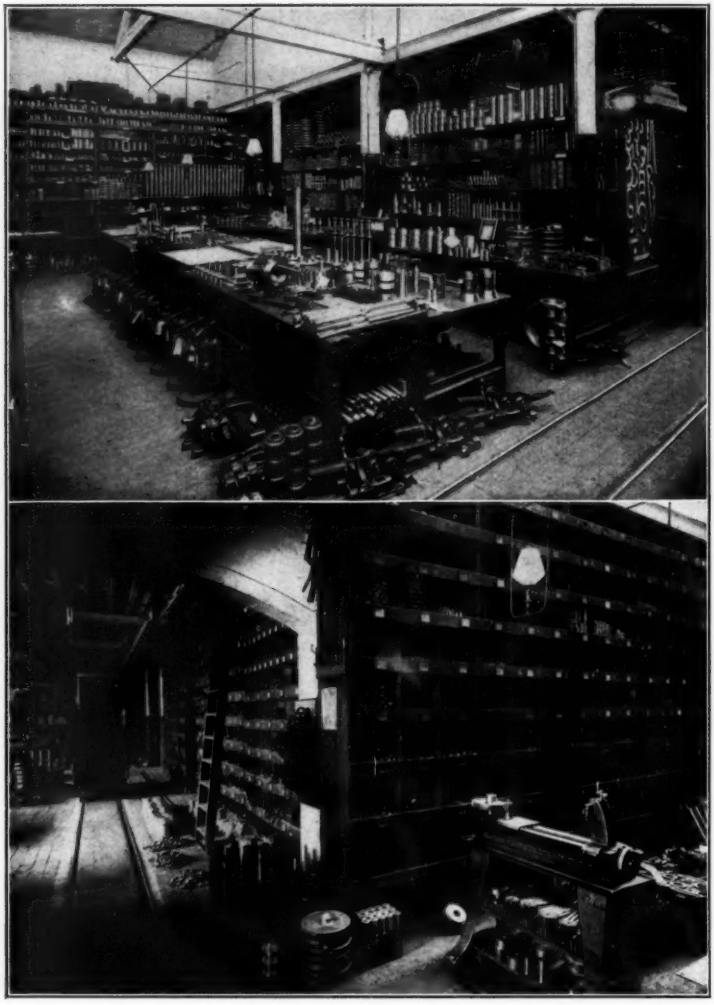
Inspected to certify quantity and finish by _____ Received into Stores and Number found correct by _____

ISSUED TO MACHINES

| Date | Machine No. | Quantity | Date | Machine No. | Quantity |
|---|---|---|---|---|---|
| | | | | | |

ORDER TICKET, REPRESENTING A LINE OF THE SPECIFICATION OR SCHEDULE OF PARTS. AS SHOWN ON PAGE 99 OF THE ENGINEERING MAGAZINE FOR OCTOBER, 1904.

The original is a white card, 4 by 6 inches in size. This is written out in the order office, submitted to the works office, and then sent to the stores department. The stores keeper gets the raw material for it and holds the card until the work is done, when he affixes his initials and sends it to the cost office. The cost keeper, after posting from the process card onto the order card, posts its total in turn to the specification sheet received from the order office.



FEATURES OF THE STORES DEPARTMENT CONDUCTED AS A CONTROL DEPARTMENT IN THE WORKS OF MESSRS. ALFRED HERBERT, LTD., COVENTRY, ENGLAND.

The upper view shows that portion of the stores devoted to inspection and storage of parts of machines in progress of manufacture. The head stores keeper and chief inspector are one and the same person. Work is returned to the stores after each operation, to be checked by the drawings, gauged, and generally inspected. After inspection, parts are kept in the stores until wanted by the works, with the object of reducing the amount of "dead material" in the shop. The lower picture shows the stores for small parts, made to stock orders on automatic machines. Standard reference numbers are shown on the cards attached to the pigeon holes.

**BLANK & CO. YORK**

Week ending .....
Work .....

Identification No. .....
Process .....
Drawing No. .....

| DAY | | Begun | Off | Begun | Fini's | TIME |
|---|---|---|---|---|---|---|
| T | A M | | | | | |
| | P M | | | | | |
| F | A M | | | | | |
| | P M | | | | | |
| S | A M | | | | | |
| | P M | | | | | |
| SUN | A M | | | | | |
| | P M | | | | | |
| M | A M | | | | | |
| | P M | | | | | |
| T | A M | | | | | |
| | P M | | | | | |
| W | A M | | | | | |
| | P M | | | | | |

| | Hours | Rate | | | |
|---|---|---|---|---|---|
| Bare Time | | | | | |
| Added Time | | | | | |
| Total Wages in week | | | | | |

**Process Card No. 14410**

**THIS SIDE OUT**

Man's No. .....
Name .....

Order Card No. .....

Inspected by .....

**PIECEWORK**

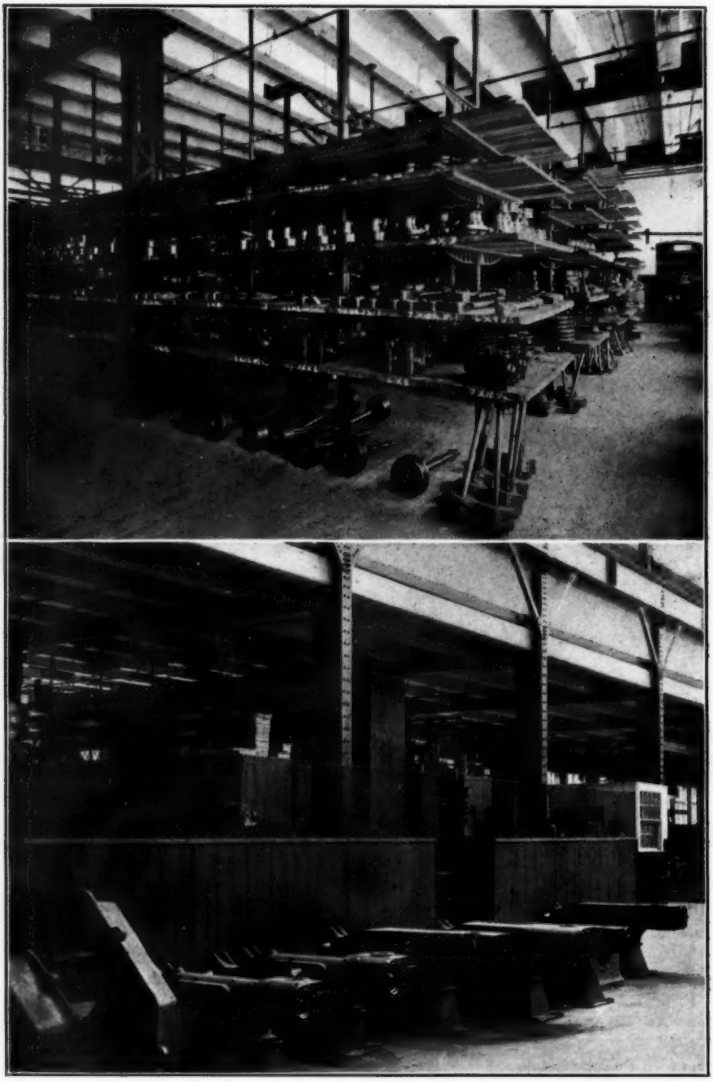
| Continuation Card Nos. | Hours. | £ | s | d |
|---|---|---|---|---|
| When work extends over the week end further time is to be marked on a yellow continuation card, which must be given same number as this. | | | | |
| TOTALS.. | | | | |

| Price | Balance. |
|---|---|
| £ : : | £ : : |

FRONT AND REVERSE SIDES OF THE PROCESS TICKET.

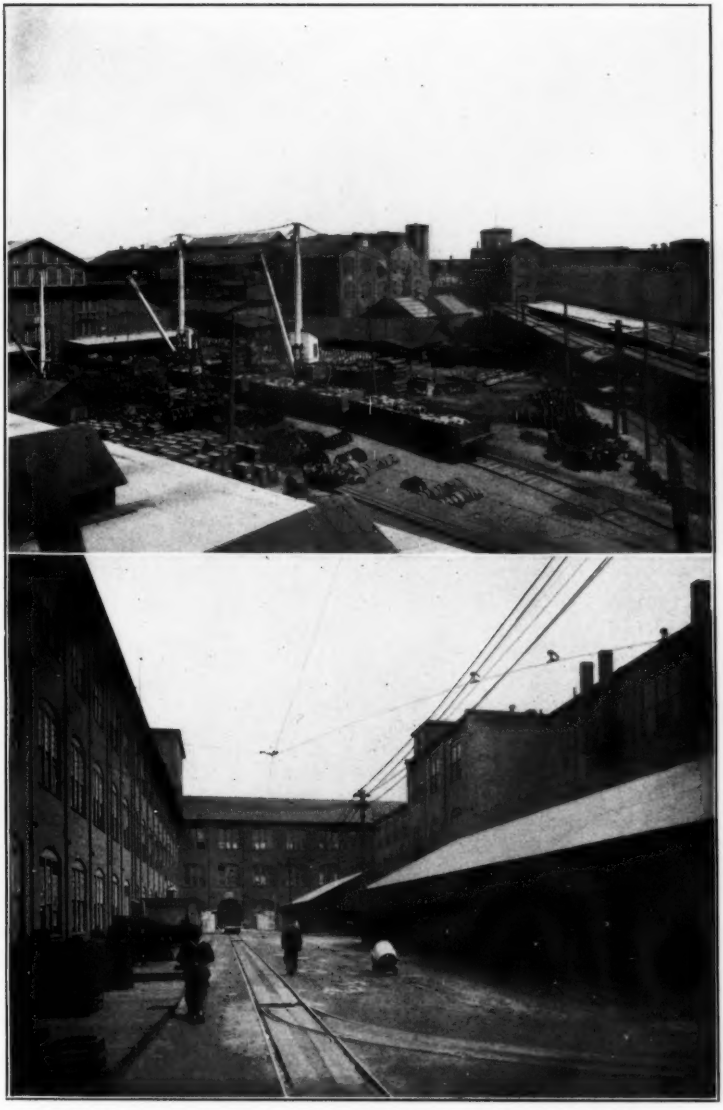
The original is a green card, 7 by 2¾ inches. This conveys all information to the men as an order, and serves as a contract for piece work, and as a time card. After passing to the stores department with work for inspection, it is noted as "in" on the order card. It then goes to be made up as a contract for payment of balance due the workman, and finally reaches the cost office where the money it represents is posted to the order card when the latter has also come in. It is used in conjunction with the Rochester Recorder.

casting in a place where it will not be tooled off; thus the man can tell at a glance which castings or forgings (the symbol should be stamped on forgings before they leave the smithy, or at least be



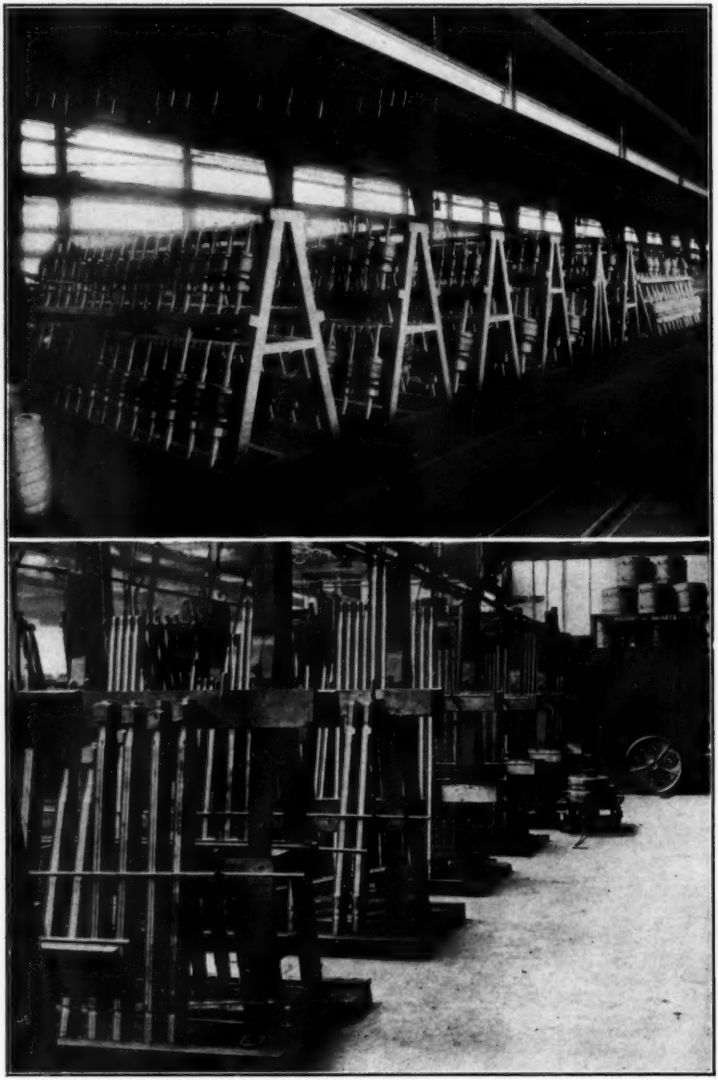
STOCK-ROOM FEATURES IN THE NEW WORKS OF THE B. F. STURTEVANT CO., HYDE PARK, MASS.

The stock room, 40 by 120 feet, is on the ground floor at the junction of the machine and erecting departments. The lower view shows the portion devoted to purchased material—bolts, nuts, etc.; metal trays were seriously considered but abandoned for the older wooden construction. The office of the chief clerk of the department is here. Delivery doors are recessed to be out of the line of overhead crane service. The other end of the room, seen above, is for storage of finished engine parts, the shelving and bracket arrangements being of original design adapted to the conditions. A brick-walled storage room in one corner is for storage of copper, tin, lead, etc., with elevator to the brass department above and chutes for chips therefrom.



YARD STORAGE IN THE SHOPS OF THE GENERAL ELECTRIC CO., SCHENECTADY, N. Y.

The lower picture represents the storage yard for castings and sheds for half-finished material, adjacent to the buildings devoted to the manufacture of switchboards, switches, and supplies. The upper view is in the yard back of buildings 4, 6, 8, and 10, and shows the electric derrick cranes and electric switching locomotive.



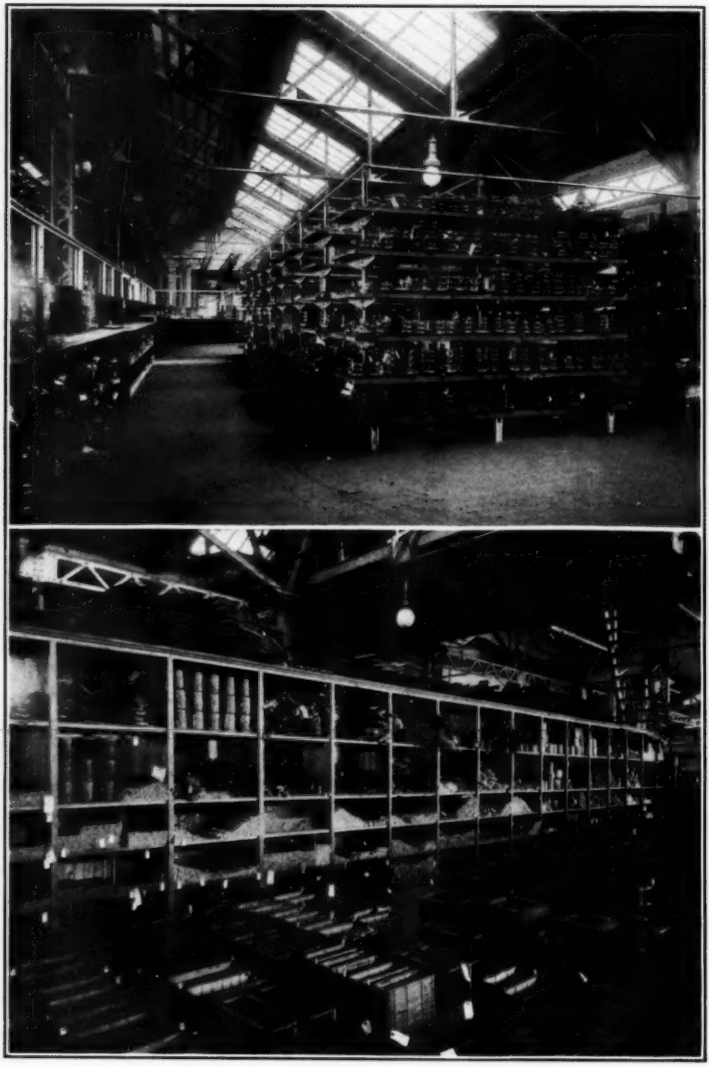
TWO EXAMPLES OF THE USE OF THE VERTICAL RACK SYSTEM IN THE STORES DEPARTMENT.

The upper one shows the method of storing armatures in the stores room of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. The lower shows the finished rod store in the pump works of Messrs. G. & J. Weir, Ltd., Cathcart, Glasgow.

painted on,) are correct for his job. The procedure in handling these cards will now be as follows:

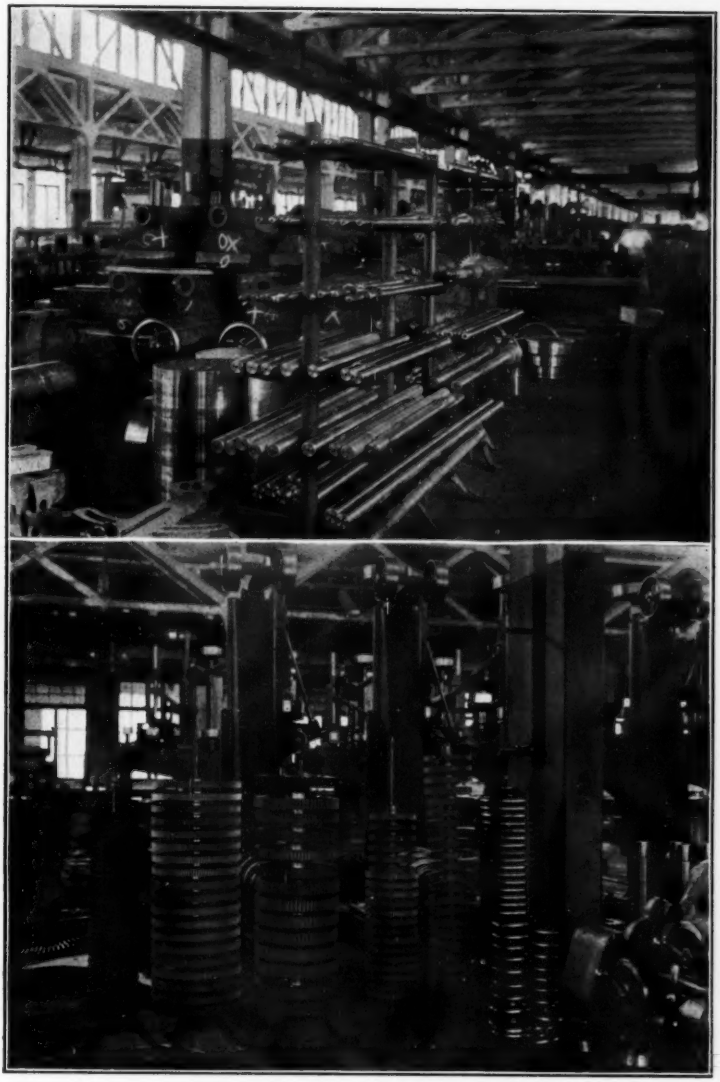
When written out by the order department (their preparation can be facilitated by the use of rubber stamps) they are handed to the piecework or premium clerk, who puts the prices or premium times upon them and passes them to the shop foreman. The latter sorts them over, assigning them to his men, who when starting the job have the cards clocked in the recorders to mark the time. They follow the usual recorder procedure until the work is done, when the inspector takes the card and (after satisfying himself that the work is correct) initials it in the space provided. The card then passes to the piecework department for the calculation of balance, if any, and from there to the wages clerk as voucher for the payment of balance. When the cards have fulfilled their function to this point they go to their final resting place—the cost office—for the cash amounts to be posted to the order card. The order card, when it first leaves the order department, would go the stores keeper to be filed by him under its consecutive number and held until the work is received in stores, actually or virtually, in a finished condition. Incidentally, when raw material is issued to the shops (the process ticket being shown to get it) the weight is booked on the order card to inform the cost office what material is used. When the last operation on a given piece of work is completed it is passed into stores by the inspector, who initials the order card to certify completion, and the stores keeper also initials the card to certify the receipt of the work and then passes the card to the cost office, to be completed and finally posted as cash to the item on the specification sheet with which the ordering started. The sheet thus sums up the information brought forward by the cards.

The frequent reference to the stores keeper shows him to be an important official through whose hands many things must pass in addition to mere articles for storage. He is aware of all work in progress through the shops, and he should know the position in which it stands. The inspectors and he should be in close touch, or better still the inspectors should be subject to his control; thus he would in reality be the head inspector. The initial specification or order sheet of which a copy is made for the cost office is in his hands, and upon it he indicates the progress of work by noting which operations are inspected. The whole of the rough material with castings and forgings would be under his control, so when his inspectors reject bad work he must see to it that fresh castings, etc., are not only in stock, but that re-orders



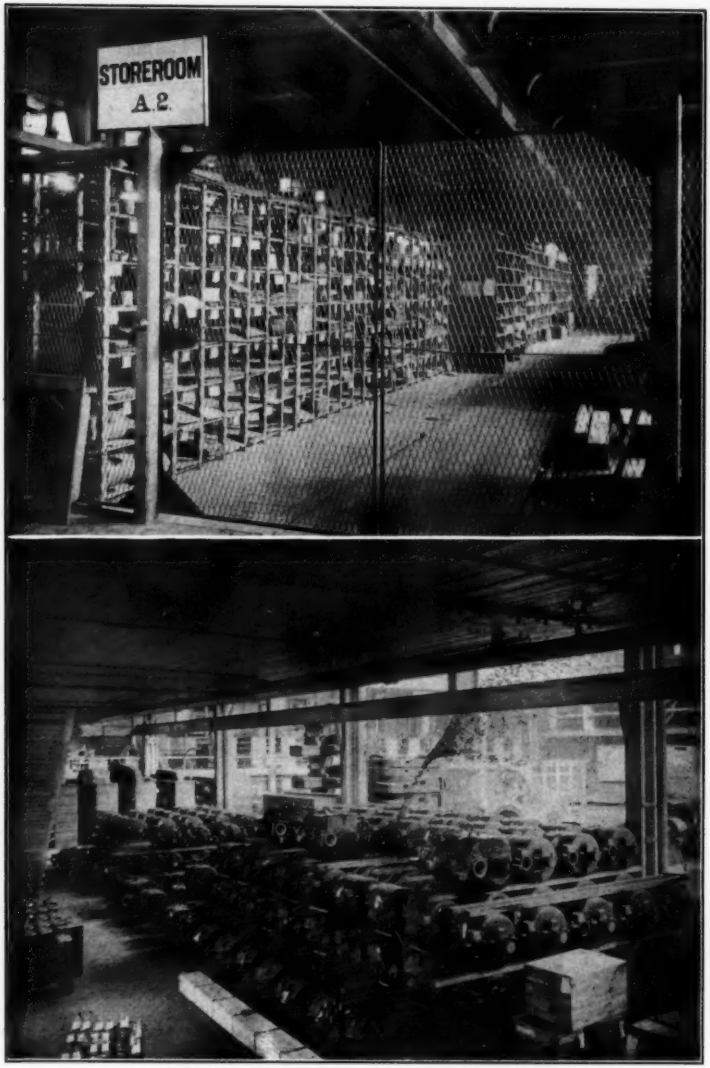
STORES PRACTICE IN THE SHOPS OF THE WESTINGHOUSE ELECTRIC & MFG. CO., EAST PITTSBURG, PA.

The upper view shows the system of storing brush holders and commutators; the lower, the storage of finished coils and insulations.



STORES ROOMS OF THE POND MACHINE TOOL WORKS, NILES-BEMENT-POND CO.

Above are seen the racks for holding bars, either in the rough or in various stages of completion. Below are the stands for holding rough castings, finished parts, or work partially completed.




STORES ARRANGEMENT IN THE WORKS OF THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO., LTD., TRAFFORD PARK, ENGLAND.

The upper view is taken in the general stores room, the lower one in the motor stores.

are set in motion to put them through the shops. The works manager should give him dates by which the work should be finished, or progress reported upon, and if the work is not coming into stores smartly enough to keep to the dates he, the stores keeper, should write an "Urge Order" which he would hand to the manager, who is thus posted as to delays; and the manager then, after impressing his stamp upon it, would forward it to the foreman concerned. A form for such an urge order would be somewhat as follows:—

**URGE ORDER.**

WORKS MANAGERS
AUG. 1st 04
OFFICE

**Respecting Order No.**.....

To Foreman.....

The following items are urgently wanted and should have immediate attention. Return this order stating condition of work and when you can finish the same. Should there be any delay, state cause and what is being done.

Items.

| | | | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
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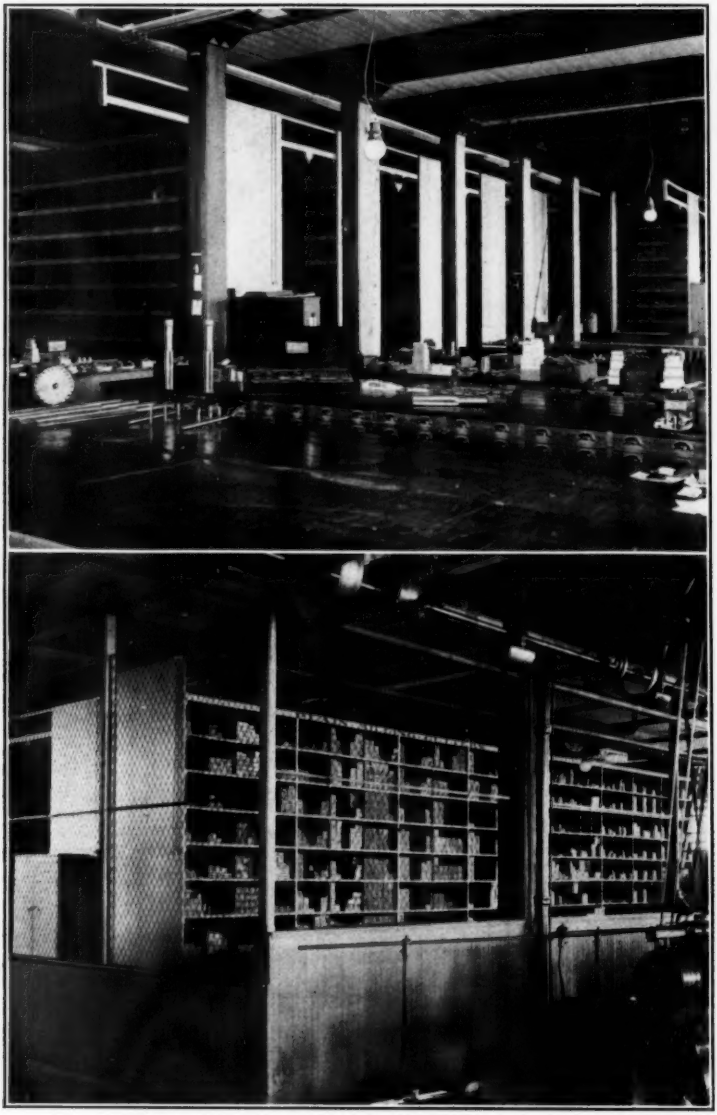
| | | | |
| | | | |
| | | | |

Foreman's Initial .....

Date.....

URGE ORDER, FOR USE WHEN WORK IS NOT COMING THROUGH ON TIME.

Printed in red, on a white card 5¼ inches wide. This is to be filled out by the stores keeper and passed to the works manager for his observation, and for his information as to jobs that are falling behind. After he has put his stamp upon it he forwards it to the foreman with any special remarks.



THE STORES DEPARTMENT OF THE PRATT & WHITNEY CO., HARTFORD, CONN.

The upper view shows the tool racks, drawers for small taps, and benches on which orders are prepared for shipment. The lower picture gives a better view of the milling-cutter racks, etc.

THE STORES DEPARTMENT OF MESSRS. MELDRUM BROS., LTD., TIMBERLEY NEAR MANCHESTER, ENGLAND.

The upper view shows the stores room, looking from the stores keeper's office. The lower view is taken in the stores room, looking in the opposite direction. The office of the stores keeper is behind the glass partition in the background.

When work is received into stores, whether rough or finished, (and we may assume that the rough work is kept in a section of the stores, whether directly attached thereto or remote, still under the stores keeper) it must be booked in the stock book or upon stock cards.

Cards are much more flexible than books in such work as this, inasmuch as they can expand or contract in number as needed, and when kept in order they form their own index. On the other hand, the leaves of books cannot very well be extracted or inserted at will and the index must be a separate matter. The stock card would be like the following:—

**STOCK CARD.** **Identification No.**_____

**Size of Article**_____

**Description of Article** _____

**Maximum Stock**_____ **Minimum Stock** _____

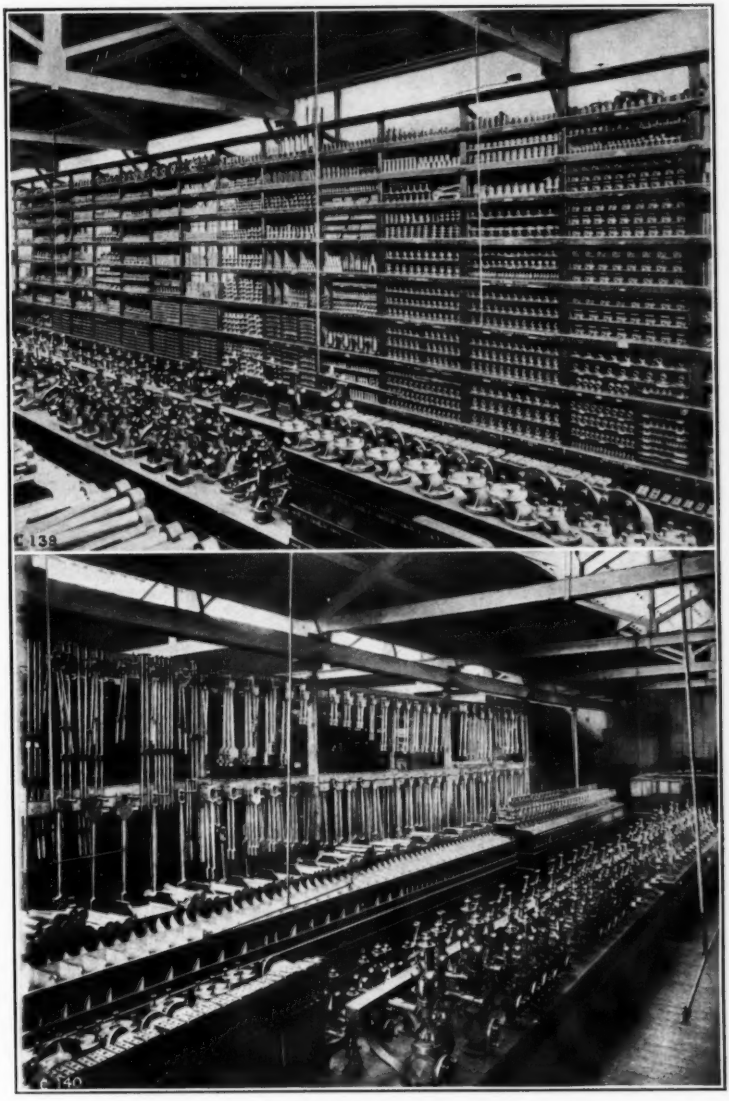
**Weight of one article Rough** _____

**Weight of one article Finished** _____

**Remarks**_____

STOCK CARD, FOR USE IN RECORDING THE QUANTITY AND LOCATION OF THE PARTS IN STORES.

The face of the card provides for identification, the maximum and minimum quantities to be stocked, and also provides space for rough and finished weights. These are useful for estimating purposes but are not necessary for stores work. Upon the reverse (page 196) provision is made for noting quantities, with dates, of articles received and issued from stores. It also provides space for the order number to which they are made—this latter information may prevent the issue of the parts for a wrong order—and it also assists in locating the work in stores; for, by numbering the pigeon holes, bins, or sections of floor space, they can be noted in the column headed "location." In this way the parts that may have been in store for quite a



INTERIOR OF THE STORES DEPARTMENT, MESSRS. MARSHALL, SONS & CO., LTD., BRITTANIA IRON WORKS, GAINSBOROUGH, ENGLAND.

long period for some reason can can be found as easily as the last arrivals, and there is no loss of time.

With parts that are standard stock and that are made to a stock order, it is necessary for returns of issues to particular orders to be sent to the cost office, and this can very well be done upon either a daily sheet or an issue card, which can be filed with the order cards.

| RECEIVED INTO STORES. | | | | ISSUED FROM STORES. | | | |
|---|---|---|---|---|---|---|---|
| Date | Quantity | Order No. made to | Location | Date | Quantity | Machine or Order No. issued for | Balance |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
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REVERSE OF STOCK CARD. THE CARD IS WHITE, 4 BY 6 INCHES.

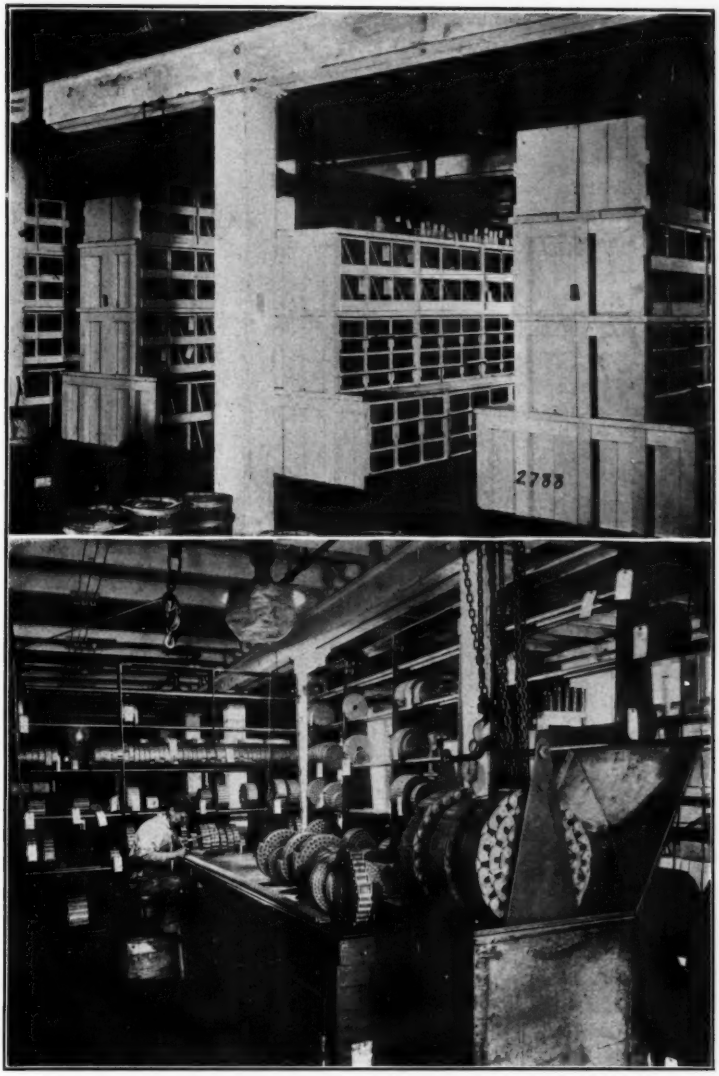
To sum up the working of such a system as a whole, in its effect on the operating of the before mentioned rapid-production machine tools and the general workshop economy:—

The system calls for the standardisation of detailed parts, itself an important matter.

It provides for the identification of parts by symbols, the same symbols serving as pattern numbers, so tending to ease and exactness of reference, and reduction in the labour of writing.

By the initial reference of orders to the stores keeper, it prevents the re-ordering of things already in stock and perhaps awaiting an opportunity to be used.

By the method of ordering, it conveys complete information to all concerned, the process cards carrying all particulars to the men; the cards also serve as piece-work or premium contracts, as time records, as balance vouchers, and as a record of progress. The various uses of the one card reduce clerical labour.




STORES-ROOM FEATURES IN THE SHOPS OF THE LINK BELT ENGINEERING CO., NICETOWN, PHILADELPHIA.

The upper view shows the bins for storage of bolts, nuts, rivets, etc. The racks are built solid, and the bins are in transferable units, shiftable at the convenience of the stores keeper. In the lower view is shown the section devoted to Renold silent chain. The tags, on which a correct balance of the contents of each section is carried, are plainly seen. The stores room is well equipped with industrial railways.

The time otherwise spent by the men in writing their time records, in finding out the order numbers and the drawing numbers, and in making other inquiries respecting the work, is saved at a cost of the time of the clerk who writes out the orders.

It provides for the maintenance in stock of all standard parts likely to be required, in such quantities as will avoid the running out of stock, and yet without inflation. By the inspection of all parts prior to acceptance in stores it secures the interchangeabilty of parts.

It preserves the continuity of the machine work by providing what may be called a "reservoir" of rough material in stores, and a receptacle for the finished work, with the certainty that the latter will be ready to hand when wanted.

It tends to reduction in assembling or erecting costs, by the systematic gathering together of finished parts ready to issue complete to the erectors, their time, which would otherwise be spent in looking up their work, being then turned to more useful account.

As the manager can obtain the state of progress of any work at any time, he is in a position to make safe promises to customers as to delivery.

It assists the foreman, inasmuch as it keeps him fully informed of all work coming forward and in hand for his machines and men; thus he can plan out his work beforehand.

The costs will be accurate, as the information sent forward is clear and definite and does not depend upon uncertain returns made by the men.

The stocking of standard parts provides for the prompt filling of repair orders, the quick fulfilment of which may often lead to good business.

The system places accurate information as to detail costs at the works-manager's command, so enabling him to make comparisons and to check excessive cost where it occurs.

Upon reading back, I feel that perhaps I have not represented with sufficient fullness the importance of the stores in such an organisation, although it may be perceived as an underlying thread throughout. The stores is, in fact, a virtual hub around which the work in progress systematically rotates until it is absorbed in detail and re-issued *en masse* to the assemblers or erectors, to be finished for despatch from the works; and when successfully operated it tends greatly to the smooth running and efficiency of the whole factory.

# THE MINES AND MINERAL INDUSTRIES OF ITALY.

*By Enrico Bignami.*

A PRECEDING article* was devoted to the mining of zinc and of lead, which hold the first place among the metals in the mining industry of Italy. In the present article we shall give our attention to sulphur, which in value represents two-thirds of the entire mineral production of Italy, and which supports an industry with many interesting aspects.

In the volume recently published by the (Italian) department of agriculture, it is stated that the production of sulphur in the last official year (1902) amounted to 564,318 tons, of the value of 53,335,600 francs (average price per ton, 96.72 francs), while the total mineral production did not exceed 80,000,000 francs. Nine-tenths of the production of sulphur belongs to Sicily, where 510,432 tons were obtained, together with 3,329,370 tons of mineral matter, representing a yield of 15.27 per cent. The other one-tenth comes from the mining district of Bologna, from the sulphur pits of Romagna and the Marches.

Almost all the sulphur obtained in Sicily is exported—three-eighths to the United States, one-eighth to France, and the rest to the other countries of Europe, especially to Germany; 44,000 tons is exported to the mainland of Italy—a considerable diminution from former years, for in 1900 the number was 95,000 tons, and in 1901, 70,000.

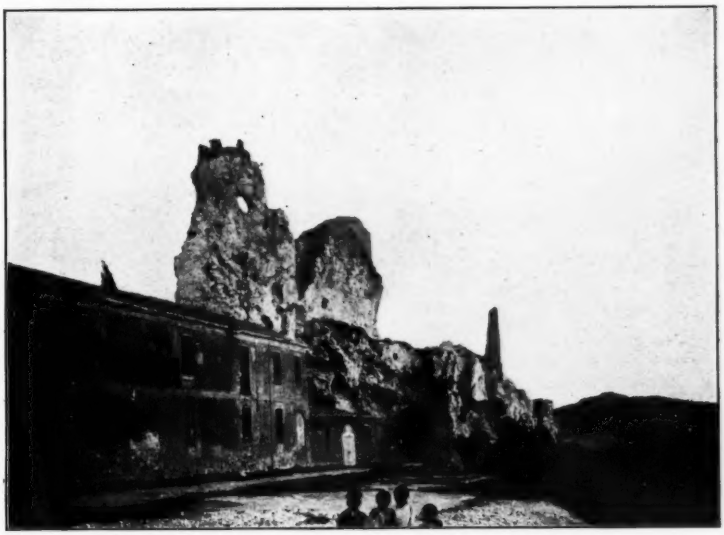
As is well-known, sulphur is a mineral of the first class—that is to say a metalloid; it occurs either amorphous, or crystallized in two different forms, as octahedrons or as oblique prisms, always with rhomboidal base. It has a vitreous structure, is fragile, and not very hard. Its color varies from clear yellow to brownish yellow. Its lustre is vitreous; it is tasteless and odorless, but if it is rubbed or struck, it has a strong characteristic odor. It burns readily with a blue flame and produces sulphurous acid. It melts at 114 degrees C., and becomes transparent; at 160 degrees it loses its transparence, and also becomes viscous; at 260 degrees it liquefies again completely; and at 460 degrees it boils.

* The Engineering Magazine, September, 1904.

TYPICAL SICILIAN SULPHUR MINES

At the top on the left, the Lucia; next to it on the right, the Gessolundo Manrelli, with a group of students from the Caltanisetta mining school. Below, on the left, the St. Jean shaft of the Quattrofiniate mine; on the right, No. 1 shaft of the Bosco mine, S. Cataldo.

The sulphur occurs free at the surface (pages 201, 202), or in mines, or sublimed in the volcanic regions called "solfataras," or combined with other minerals. The industry of sulphur production consists in the extraction of that substance from the earth, its separation from foreign substances with which it is mixed, and its transportation to markets.



AN EXPOSED SURFACE OF THE SULPHUR-BEARING LIMESTONE, AT CALTANISSETTA.

The industry has great importance in the national economy—very great indeed in the regions where it is especially carried on, as in Sicily and Romagna. In the economy of the nation, it represents, as already said. a value of 50,000,000 francs, and the labor of 50,000 workers—that is to say, the subsistence of nearly 25,000 families, or about 100,000 persons, who derive their living from it.

The sulphur occurs naturally in layers or beds, included in the rock of calcareous sediment containing gypsum or clay belonging to the tertiary period, or, to speak precisely, to the miocene. Its formation is due to hydrochemical causes which acted upon calcium sulphate. The causes of this transformation are not yet thoroughly understood, so that as yet we have only hypotheses. The most favored hypothesis is that powerful emanations of hydrocarbons, coming from lower layers and under enormous pressures, acting upon the calcium sulphate in solution or during its deposition, reduced it to sulphur and lime.

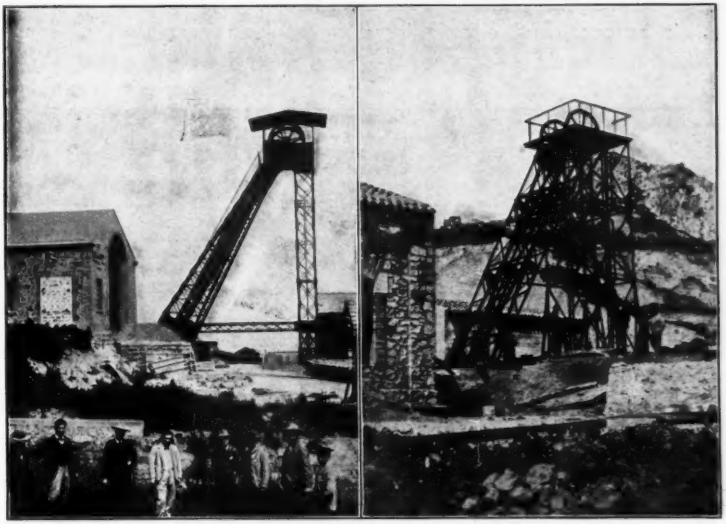
SURFACE WORKINGS FOR SULPHUR, WITH WASTE HEAPS OF EXTRACTED ORE.

The usual form of the beds is that of a horizontal lens. In fact, by reason of the almost circular and concave form of the bottom of the basins and the law of molecular attraction acting at the moment of the sedimentation, if there was no disturbing cause they would not have been able to take naturally any other form than that which they ordinarily have, The abnormal forms, which are seen in some deposits, come from several accidental causes. It is to be noted, however, that all the deposits have a greater thickness in the middle and a smaller one at the ends, and have greater richness in the central layers than in those near the top or near the edges.

After making the borings necessary to obtain an exact idea of the depth, thickness, and direction of the deposit, other work of no less importance is taken up, that is to say, construction of passages of entry to the deposit, so as to be able to exploit it. These passages may have various forms; the layer of mineral may be reached by horizontal galleries, by inclined planes, by galleries of more or less steep slope, or by vertical shafts (as seen on page 200). Ordinarily the shaft has the double purpose of extraction of mineral and withdrawal of water; but the two functions are sometimes fulfilled by the same passageway, and sometimes by separate ones. The former case occurs when a special installation of pumps is not available. In the

latter case the shaft is divided longitudinally by means of cross pieces and vertical timbering into three sections. Through two of these sections the cages for the hoisting of the mineral move without interruption; in the third, the pumps for extraction of water are installed, with pipes, conduits, air chamber, and accessories. The single-action pump is situated near to the sump at the bottom of the shaft, and its powerful pistons are able to raise the water in a single jet up to the mouth of the shaft, even if it is 200 or 300 metres above. The pumps are usually driven by electricity.

The most insidious and serious dangers in the mines are the gases, which develop within the rocks and rush out impetuously during the work. In the solfataras those commonly occurring are hydrogen sulphide, carbonic acid, and marsh gas. The first is poisonous, the second asphyxiative, and the third inflammable and explosive. Hydrogen sulphide is contained in the sulphurous waters. For this reason, whenever one is about to come upon a body of sulphurous water, the characteristic odor of putrefied eggs is observed. It attacks the mu-



SCENES OF MINING ACCIDENTS IN THE SICILIAN SULPHUR DEPOSITS.

The headworks on the left are at the Trabonella mine. The manager, Mr. Loria, who is shown (in a white suit) standing in the midst of a group of students from the mining school of Caltanissetta, was killed by an explosion of fire damp in October, 1903. On the right is the Guilia shaft of the Trabia mine. Here Comm. Richard Travaglia and Chev. Louis Fiorentino were killed by hydrogen-sulphide poisoning in August of the same year, other engineers in the party being saved by the heroism of a head workman.

cous of the eyes, which become red and dry, can not bear light, and suffer sharp pain, extending to the temples. It also attacks the respiratory passages, through which it is absorbed into the blood, and produces immediate poisoning.

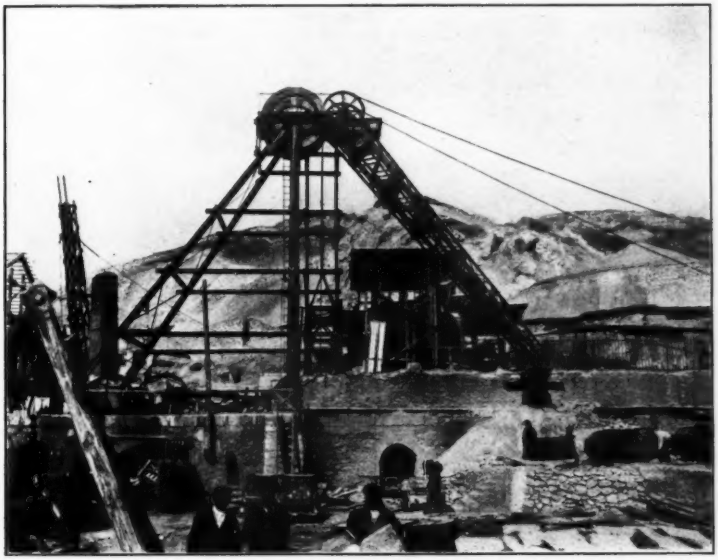
The carbonic acid is produced by the decomposition of the calcareous and argillaceous tufas, or it may be enclosed in the cavities of the calcareous rocks. It manifests its presence by extinguishing the lamps and causing fatigue in breathing. If one notices its presence, it is necessary to go immediately to fresh air, as it is utterly unfit for respiration.

Marsh gas, or carburetted hydrogen, is the terrible fire-damp, which claims so many human victims in coal mines. It has neither color nor odor, and that is why its presence is not observed, until, having accumulated where work is going on, having mixed with oxygen and come into contact with the flame of the lamps, it causes a terrible explosion.

It should be mentioned here that safety lamps for oil or benzene, like the Davy lamp and those which are derived from it, do not fulfil their purpose, and electric incandescent lamps are the only ones which completely satisfy the exigencies of service.

When the necessary works for reaching the deposit of sulphur

INCLINED PLANE AND MECHANICAL HAULAGE PLANT, STINCONE MINE, S. CATALDO.



TRABIA MINE. HEADWORKS OF THE MAIN HOISTING SHAFT.

are finished, the working begins by the extraction of the mineral, which is done by hand laborers with pickaxes. One or two work together during the day, and one or two during the night in each underground passage. The shift of laborers thus takes place every twelve hours. Each laborer is provided with a pickaxe, timbers, and one or more willow baskets. One or two of the pickaxe laborers have at their disposal one or two or several "carusi (see page 206), whose duty it is to carry out the mineral in sacks or in wooden wheelbarrows. Sometimes they carry the material to the exterior of the mine, sometimes to the end of the gallery communicating with the shaft or inclined plane by which it is hoisted, and sometimes they fill little cars which move upon rails and which the "vagonieri" push to the shaft, from whence they are drawn up to the outside. Taking account of work days and holidays, of days of greater and of less activity, the average amount extracted in a year by a single pickaxe laborer may be calculated as nearly 400 cubic metres. Besides the pickaxe laborers, the "carusi" and the "vagonieri," there are other workers in the mines called "spesalori," who have special charge of making all necessary repairs to the passageways, of all rubbish and disposal of waste material, and of all the ventilation passages through the barren rock.

In the exploration of the deposit as to its thickness and width, parallel galleries are made, which reach as far as the barren rock. After this the method of working is chosen. The most rational method is one which is recommended by practicality, safety and economy. It is called "per ripicui" (method of filling in), and offers the following advantages:

CARUSI, OR CARRIERS OF SULPHUR FROM THE MINES.

1. Prompt use is made of all mineral that exists in the mine.

2. Systematic provision is made for cutting out the masses that are included between the galleries and cross-galleries.

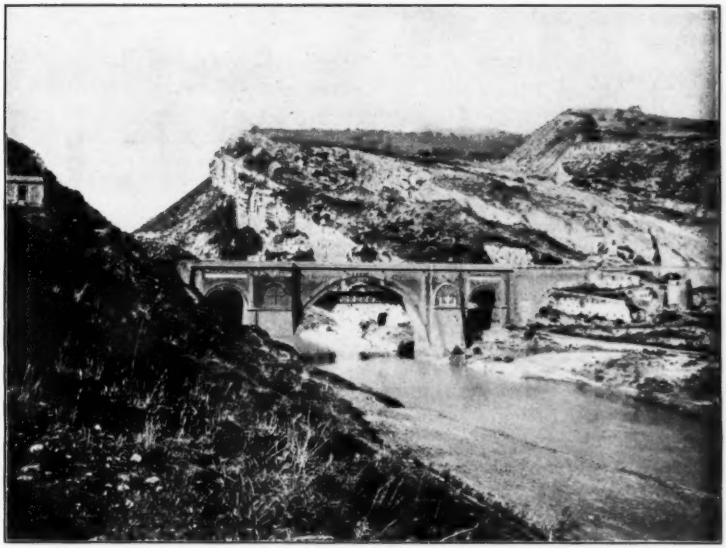
3. The safety and solidness of the mine are provided for.

4. The considerable expense of maintaining the galleries is avoided.

5. The expense is avoided of getting rid of the barren material, which often occurs within the sulphur deposit.

6. The danger is avoided of the accumulation of deadly gases in abandoned galleries, which usually spread to the place where work is in progress.

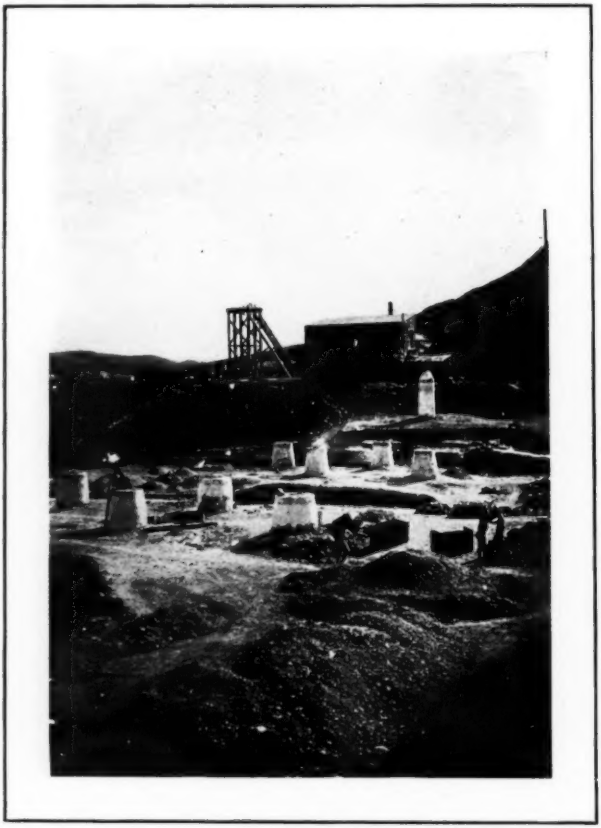
The slight difference in density of specific gravity between sulphur and its gangue prevents its separation by sorting or washing. The sulphur industry thus has no other method at its disposal but that of fusion, or of distillation. The fusion is the most important operation in the sulphur industry, and requires special care and intelligent and thoroughly practical direction. A very rich mineral, of which



CAPODARSO BRIDGE, CALTANISSETTA, SHOWING THE PLIOCENE TUFAS OVERLYING THE SULPHUR-BEARING STRATA OF TRABONELLA.

TRANSPORTATION OF SULPHUR, ASSARO, SICILY.

the melting is not properly understood, will yield less than a poor mineral, of which the fusion is understood; while the latter will not give anything if the fusion does not succeed.



FURNACES FOR THE FUSION OF SULPHUR FROM THE ORE, QUATTROFINIATE MINE.

The open furnace in which the sulphur itself is used as fuel, is called the "calcarone"; it is so common in Sicily, and also in the mines of the main land, that it may be said to be superior to all other apparatus of fusion. An improved modern modification of the calcarone is the Gill furnace, named after its inventor. These furnaces are built in groups of two or three, back to back, and communicating with each other. They are cylindrical in shape,

and covered by a dome, at the center of which there is a circular opening. Their capacity varies from 8 to 48 cubic metres per furnace.

A remarkable improvement has been made quite recently by using steam as source of heat, instead of burning the sulphur; the Gill furnaces are thus transformed into closed furnaces, the fusion of the mass of mineral contained in them being effected by internal heating. These closed furnaces consist of a double-walled iron chamber, upon the bottom of which is fastened a pair of rails connected with a small railway outside, by which two or several little iron cars with gratings at the bottom and filled with mineral are introduced into the chamber. When the chamber is closed the intense heat developed causes the fusion of the sulphur in the little cars; it flows through the grating and collects, by means of a channel, in a reservoir outside of the chamber; from there it is cast into moulds. A few minutes are sufficient to complete the fusion. Then the hinged door is opened, the little cars are withdrawn with an iron hook, others are introduced containing mineral to be melted, and the operation is repeated again and again.

The laborers in a mine may receive a daily wage, or may be paid by contract for a definite quantity of work. The pickaxe men are paid by day, receiving 2 to 3 francs daily; the "carusi" get 0.75 to 1.50 francs, and the "vagonieri" from 1.50 to 2.50. The contract price paid is from 12 to 30 francs per box (of 4 cubic metres), or even more, according to the distance of the working passage from the point where the material is to be delivered, the hardness of the rock, the quantity of worthless matter mixed with the mineral, and the means used in extracting it.

One who does not wish to manage a mine may let contracts for the exploration, excavation, extraction, and fusion of sulphur of the whole mine, or of a single part of it. Contracts are made on the basis of the quintal of sulphur fused. The usual price varies from 2.50 to 4.00 francs, according to the expense of production and delivery of the mineral. From that price, 1.70 to 2.20 francs are deducted for the expenses of shafts, machinery, etc.

The exploiter of the mine would be able to make better conditions if he could escape certain onerous terms ordinarily established in contracts with proprietors of mines. Among others there is one by which the exploiter can not free himself from the proprietor in case he has capital of his own, or finds someone who will supply it to him on better terms. According to the richness of the mineral, 20

francs borrowed for a few months may give interest of 2, 4, or 8 francs, or even more; that is equivalent to an annual interest of 40, 50 or 60 per cent., or even more.

The technical personnel consists of engineers and experts, who usually come from the universities, higher technical schools, and mining schools, and who have the licence and the scientific and technical knowledge necessary for the proper management of a mine.

The price of commercial cast sulphur varies according to its quality. According to the custom of trade, three classes are made, first, second, and third. Each of these classes includes three subclasses, superior, good, and ordinary. The purchase of sulphur is made by merchants, who sell it again to the manufacturers who transform it; or it is purchased by brokers who buy for foreign houses, or by men who sell to factories where derived products are made, or even directly by the factories. The sulphur which the producer sells to merchants at the mines is destined to undergo numerous transformations, according to the use to which it is to be put; it contributes to other industries, and is the source of many derived products.

That which goes to the refinery is melted again, distilled, purified, and then sold to textile factories and spinning mills for wool, cotton, and silk, which make use of the decolorizing and bleaching properties of sulphurous acid. The mills which reduce the sulphur to powder sell their products to the farmers, who make use of the insecticide properties of acids of sulphur; to manufacturers of explosives, who make use of its inflammable property; and to tile makers, who furnish tiles for northern countries, and make use of the property of resisting severe frosts which clays acquire when mixed with sulphur. The sulphuric acid factories, which burn the solid sulphur into acid in leaden chambers, sell their product to chemical factories. The sulphate of soda is used in soap making, in various kinds of glass making, and in pottery. The sulphate of copper is used in dyeing, and for the preservation of wood for building, for the disinfection of grains, and for the cure of vines infected with peronospora. The sulphate of iron is used in dyeing, in painting, and in the disinfection of wells and drains. The sulphate of potassium is useful in fixing the colors of cloths; that of aluminium, in tanning; and those of magnesium and of zinc, in medicine, the former as a purgative, and the latter as a mild caustic. The extensive use of sulphur and its derivatives is the reason why it finds a market so readily.

# OBSOLETE METHODS AND CURRENT PRACTICE IN SHOP ADMINISTRATION.

*By Egbert P. Watson.*

New and important movements, in the first flush of their power, are apt to be carried to extremes, and the modern tendency toward "system and organization" is probably no exception. It does not impugn the necessity of systems to large works to admit that small works have no doubt, in some cases, been seriously overburdened by elaborate and complicated commercial and clerical organizations which their productive capacity did not require and could not well support. Mr. Watson's review sounds a note of conservatism which will be welcome to many who find themselves unable to follow the modern pursuit of "system" to the extremes occasionally advocated.—THE EDITORS.

THE whole trend of modern machine-shop practice—indeed, of all manufacturing involving the use of machinery—appears to be toward constant increase in the search after and adoption of labor-saving appliances, on the one hand, and constant increase in the development and elaboration of systems, on the other. The entire movement seems to me to be epitomized in the recently published "Second Labor-Saving Number" of this Magazine.* A careful reading impressed me with the great value carried not only by the articles, but also by the illustrations, in the way of information and suggestion of the methods followed in conducting various departments of many well-known plants. But these seemed to me to be at the same time witnesses to something which has, possibly, been overlooked by managers, and this is the very large clerical force required to do what is, in many cases, routine work.

If these persons were all of them in the nature of handy men—that is, first-class laborers—and receive the pay of such helpers, they would still be an onerous tax on the pay roll; but in one department at least, the average rate of pay must be $3 per day. In a force of fifty men this means $150 per day, or $45,000 per annum, for the salary list only of one branch of the business. Doubtless the managers have seen this expense and considered it warranted—indeed, necessitated—by the system in force in their own particular shops.

Now, system is neither more nor less than method. All shops have some way of working which is best adapted to the conditions of the work and the idiosyncrasies of those who direct the actual operations, and there are nearly as many systems as there are shops. Managers

* THE ENGINEERING MAGAZINE, July, 1904.

"read, mark, learn, and inwardly digest" what is being done by others, and adopt such parts as seem good to them, with innovations or changes to meet their own needs. It is scarcely possible to take up a technical journal, or even a trade paper, that has not an illustrated system of some kind for producing goods, all of which goes to show that in the making of systems there is no end. A difficulty with many of them is that a slight departure from routine involves or is the cause of much friction all along any given line. Few systems are elastic enough to admit of changes of form without throwing everything out of gear. An example of perfect harmony of action is found in an automatic machine, say for producing wood screws, or pins. The material goes in at one end and comes out of the other commercially perfect; the process is wholly mechanical; but when the human element is introduced by systems, there is always the possibility of derangement through the fallibility of man. This is only a roundabout way of saying that no system is perfect, as many have found to their cost.

This brings me to say that system is possible in a draughting department to a limited extent only. The filing of records, or cataloguing of plans for different machines and their details, is simple; but this cannot be said of plans for new machines, or tools of any description in process of re-construction. After they have been completed they become part of the records and cause no trouble, but until they are some one has to "watch out."

Suppose, for example, that a certain standard machine is to be changed in one detail to suit the needs of a customer. It is to have a platen with a ball joint at the bottom, so that it can swivel in all directions to work at any desired angle. All of the regular patterns of the standard machine can be used except the old platen, but the feed-gear must be altered to act on the new platen. All through the works, every one connected with the production of the new-old tool has to be advised of the alterations, in spite of the fact that the drawings for the alterations are for changes, and are *not* the standard machine. This interferes with the routine established for the old machine, with which all concerned were perfectly familiar, and throws the system out of mesh for such time as the changes are going on, or until every one has become familiar with them.

In large measure, also, it accounts for the enormous force required in some drawing rooms, for in many instances new men have to be taken on to attend to new work, or new-old work, and these men are kept regularly thereafter, or for some time, in case of exigencies that after all may not arise. It is beside the question to say that radical

changes in standard machines should never be made; that is as it may be. As part of the business policy of a works, the responsible parties may be justified in filling every demand of consumers, but it seems wholly probable that it is costly advertising.

Comparison of concerns of equal standing in similar lines of trade are scarcely possible, as a criterion by which to judge whether one or the other is not well managed; but judging by surface indications and observations made on the premises of both by a person familiar with all the operations carried on, there are marked differences. One shop which made all kinds of work, and made changes as they were desired, had a force of ten or twelve draughtsmen, while the other had twice as many. The same is true of the clerical force, or those who are not actually employed at handicrafts; modern shops seem to require much larger staffs than concerns whose output in dollars and cents was very large fifty years ago.

The shop in which I was an apprentice in 1851 employed in good times about 3,000 men of all trades. The work was chiefly engines and boilers for all uses, sugar mills, pumps, stationary and marine engines, etc. There was great variety in the work and the character of it, for the engines were of several types—oscillating, inverted-cylinder, inclined, overhead-beam, side-lever, and others. Drawings were required for all parts, and the forgings and patterns were made from the machinists' drawings, with allowance for finishing. By this method but one set was needed for the job, not only reducing the cost but preventing errors by duplications. I never saw more than four men in the drawing room at any time, and the chief draughtsman was outside superintendent a large part of the time and did but little actual work at the board. There were no blue prints in those days, so each working drawing was made upon heavy drawing paper, figured to dimension with good plain figures, mounted on a suitable board, and varnished with shellac. Then the drawings went into the shop and were followed accurately to the figures marked on them. Such a thing as an error or mistake from going by the drawings never occurred to my knowledge, and if there had been I should have found it out, for, like the average boy in the shop, I had my nose into pretty nearly everything in those days. The drawings were simply removed from the boards when the job they belonged to was finished, and filed in drawers for further use unless too much worn; when they were in this condition a new drawing was made at once and filed so that the set would be complete.

Now it seems to me that this was a very good system indeed, as I recall it, and one that accomplished all that was required with a mini-

mum of office force and time. It must be remembered, too, that there were no adventitious aids to business records in those days—no type writers, no adding machines, no loose-leaf ledgers or their equivalent, no card systems of reference, nothing whatever to reduce labor, or save time. Everything required manual and mental energy, and it seems to me at this distance from the theatre of operations that the clerical force employed fifty years ago to look after and keep track of an establishment working 2,000 men ordinarily, and one-third more when in full blast, accomplished a great deal with no more than the usual systems. To recapitulate: there were three men and an assistant in the office proper; one of these was a timekeeper. There were four draughtsmen, and two men in the store room to give out files, red lead, etc. That was the whole clerical force, and it was housed in a small two-story building across the street; the main office was a small back room about twelve feet square.

Now the amount of work turned out annually by this concern was very large for the times, and by no means small at this day. There would be four or five beam engines from 750 to 3,000-horse-power, with their boilers and paddle wheels—and let no one imagine that these last were a small factor in the labor question, for they are ll work from the first to the last. It was hand work, too, for machines cannot be used except in drilling holes, and not always then. There would be some stationary engines building, with their boilers, and, in addition to the new work, a lot of steamships and steamboats to be repaired, beside the general overhauling of factories in the vicinity periodically. Altogether hundreds of thousands of dollars worth of work were turned out yearly, every bit of which had to be carefully followed up for financial leakages. The time keeper was a man well along in years, who went around morning and evening among the men to see what they had been doing, and he personally interviewed every single man. No foreman handed him a report of what men were present or absent; he got the live voice of every person in the place, and if any one was absent when the time keeper came around he was docked half a day, upon general principles, to teach him to be in his place at the proper time. This dockage was restored the next pay day upon absolute proof that the workman was in the shop, but unavoidably absent for the moment. For instance:—an apprentice, let us say, found himself 50 cents short on pay day; upon presenting his pay envelope, the contents of which were marked in ink on the outside, he was compelled to explain where he was before the 50 cents would be refunded. In most cases he had been out of the shop with a gang upon repair

work; then he would have to give the name of the foreman of the gang, and obtain his endorsement upon the envelope that he had put in full time, before he could get the shortage made up. The actual paying of wages was very quickly accomplished—inside of an hour, I think, for the whole force. They assembled outside the works after six o'clock in a certain order—all the boiler makers first, then the blacksmiths, pattern makers, coppersmiths, and others. Each man's name was called and he stepped forward; on a fast walk the whole shop was paid off without a hitch. The time keeper and a clerk did the whole business every week, and complaints were few and far between. Now if it is borne in mind that the time keeper had a long distance to travel twice daily, up and down many pairs of stairs, and aboard ships when there were any in the dock, it will be conceded, I think, that he earned his money. Are there are better systems in vogue to-day which can pay off and keep track of 2,000 men of all trades, check their time, and make up the pay roll by the labor of two men only?

In the machine shop proper, where all the work was set up, I am free to say there was no system whatever, except the supervision of the foreman to see that the tools were kept going and the fitters employed. There was a tool room, or an apology for one, where some tools were kept when the man who took them out happened to remember to bring them back, but there was no penalty for "losing" them, and it was currently believed that some of them found their way to neighboring junk shops. There were no arbors, or mandrels as they were then called, each man making one as he needed it from a piece of scrap iron, with centers struck by a common punch. After they had been used for a day or so the condition of them can be imagined.

It must be borne in mind that the machinists' art was very imperfectly developed half a century ago, and things which seem incredible now were common practice then. The machines themselves left much to be desired as regards accuracy and fitness for their purposes, and in this direction there is no computing how much machinists owe to tool makers for their enterprise and skill in furnishing lathes and planers, to say nothing of special tools, that are absolutely accurate. I can look back now and see where we wasted time and money by cut-and-try methods which would not be tolerated in these days, and where, for want of accurate measuring machines, one man's inch was 33-32 while another's was only 31-32. This was not through carelessness or want of skill, but was caused by the want of system which permitted every man to furnish his own standards. In this direction mod-

ern practice cannot be too highly commended; what with limit gauges micrometers, etc., there is no reason why an inch in Georgia, for instance, should not be an inch elsewhere.

There are several kinds of work which come under the generic term of machine, but they differ from one another in degree only; all of it is metal work, whatever may be its class. A man who has learned his trade in a machine-tool shop is a machinist, but he is not capable of marine work until he has learned the differences between the two classes. In one, the former, the fits are close and exact, while in the other there is a certain freedom required in some details so that they can come and go slightly to avoid heating. I mention this because in discussing ways and means we must consider the instruments, human agencies, by which desired ends are to be attained. It makes all the difference whether the man or men we employ are of a high class morally and mentally, or mere hewers of wood and drawers of water, without ambition to rise in the world. This applies as well to the heads of departments as it does to the workmen themselves; temperament enters largely into the question of the success of systems, of whatever nature. A designer of systems or methods to get out work may have all the constructive faculty there is, and yet fail because of inability to direct and carry out his conceptions in concrete form.

I can make this clearer, possibly, by saying, referring to a preceding page, that modern machine making requires the services of a class of men who are quite distinct in their several lines. For want of a better name they are called tool makers; they supply all the small tools, jigs, and appurtenances of whatever name or nature that are needed to do work accurately and expeditiously. Necessarily, these men must be versatile, or able to do everything possible and impossible, one would say at times, that metal is capable of. Not only this, but they must be quick of apprehension, and wholly free from personal bias as to ways and means to accomplish certain things. This requires considerable tact, for there is nothing more annoying to an experienced designer who has, presumably, surveyed the limitations of his ideas thoroughly before fixing them in metal, than to have a well-meaning workman begin to suggest different ways of arriving at the same result before he is asked to give an opinion in the premises; and just here the designer has need of all his self control to give the soft answer that will show the workman that he is exceeding his privileges; he may have more ingenuity than the "super" has the exercise of, but a little common sense would show him that it is bad policy on his part to put it in evidence. Good tool makers are scarce, and it is a curious

fact that the result of their work is to lessen the visible supply of general machinists—that is, men who can run any tool, are handy at the vice bench, and can read drawings at sight.

Jigs are mandatory; there can be no misinterpretation of their edicts; it is impossible to drill holes in the wrong place or of the wrong size with them, the whole procedure being definitely fixed beforehand; this being the case, the workman has no mental work to perform, not even as to the sequence of operations, for, in many establishments, these are listed for him by some one in authority. In turning, the shapes of tools are also prescribed, his vagrant fancies or predilections in favor of his own shapes for certain parts of the work being tabooed. All this routine work seems to me to be destructive of originality and improved methods, for those followed are conservative. This view of the matter is taken by some firms, who have foreseen the possibilities and allowed for them by establishing a system of reward for suggestions from the shop force which may be adopted as betterments.

In arriving at these conclusions I have been careful to get the views of others upon the subject, and find, as might have been expected, that there are some who feel that good, all-around, versatile mechanics are no longer required. The practice of specializing and fitting up shops to manufacture stated lines of work is so general that the demand for men who can fill any place in a machine shop, equally at home on machine tools, vice work, or the floor, is becoming smaller annually, so that it is only a question of time when the old-timer will be as extinct as the dodo. In opposition to this I have quoted papers and instances from articles in THE ENGINEERING MAGAZINE which show that firms are taking great pains with their own pupil-apprentices to give them a full knowledge of all branches of the trade so that they may obtain a thorough knowledge of it. This was conceded to be the custom, but it was asserted that good mechanics could not be made by such methods, for the time spent in each branch was too short to gain an extended working knowledge of the trade; moreover, such men, so soon as their terms of apprenticeship had expired, found that they could get higher wages as specialists than they could as general utility men, so they learned to do one thing well instead of many things superficially.

As to the force of this aspect of the subject I am not competent to speak, for I have had no acquaintance with specialists; but I have a wide circle of friends engaged in businesses of a mechanical character, requiring a good working knowledge of the machine trade. Their views are that versatile mechanics are badly needed at the present, and

that the time will never come when they can be dispensed with. From my own point of view I have observed more ordinary machine shops where work is carried on by the usual machine tools than I have those whose output is produced by special devices. I have visited many of these last also, and had, a few years ago, a very thorough knowledge of the systems followed—necessarily so, for I supplied much of the material used in many of them. For certain operations there were special machines, but the entire outfit was not of this class, and there were a good many men at work who might be called general machinists.

Enough has been said for purposes of comparison between obsolete and current methods in shop systems. The necessity of the latter in one form or another is unquestionable; the results will show for themselves, when a balance is struck, whether they are profitable or the reverse. It is worthy of note, however, that the enormous gains said to have been made by reducing the time for certain kinds of work, by offering bonuses, by high-speed steels, and by special tools, have not resulted in reducing the cost of machine tools to consumers of them. Not having a list of average prices the country over, or of those which prevailed half a century ago, I cannot draw parallels, and impressions are valueless in this connection. Whether profits are greater now than they were fifty years ago, must be left an open question; but there is no doubt at all that in the matter of surroundings, conveniences, and comforts of one sort or another, workmen are far better off than they were years ago. I need only specify the lavatories, lockers for clothes, lighting and heating of work rooms, to say nothing of latrines, retiring, and bath rooms, where every convenience is provided, to prove my assertion. These things cost the administration a round sum annually to keep up,-and they are under no legal obligation to furnish them. Wages, too, have doubled in amount in the half-century. I do not include the upkeep of libraries, free schooling for apprentices, free dining rooms, etc., in my citations because they are not universal, but even cursory examination will show that the sanitary conditions of shops is much higher in the scale of civilization than it was.

I confess myself puzzled, however, when I see the mechanical aids to mental labor in counting rooms, and the very large staffs of employees to use them. One would say that the reduction of time and labor brought about by them would tend to reduce the force as well, but it seems to have the contrary effect. I am told by some who know more about modern systems than I do, that it is a part of certain methods employed, and they admit it is expensive, but not so much so

as it would be to dispense with it. I talked with a friend now in business for himself who was at one time in the employ of a concern that did an enormous business, sending out six hundred invoices daily, and no shipment was permitted to be made until the invoice had preceded it. They had an office force of about a dozen persons, and have since increased it. I asked if any mechanical aids were employed, and was told that an adding machine was used on long columns of figures; that was the only one. Now it seems curious that if, fifty years ago, three or four men could take care of a million dollars a year, it should require ten times that number to do work now to the same amount. I said this to my friend, and he replied that it was doubtless owing to the difference in the nature of the business and the systems employed. I answered that in the first instance there was no system as such; in the second, that their system was an enormous tax on the annual output, to which he assented, inferentially, by silence. I should have stated before that the concern above mentioned did a retail business connected with manufacturing, which accounts for the large number of invoices made out daily.

In a certain sense, systems inaugurate themselves, for where there is an established line of work to be turned out facilities must be provided to do it at the lowest possible cost. This means a system or plan of procedure of a routine character, the one adopted being, in a great measure, governed by the character of the job. My view is that systems will increase in number, and are increasing, but that there will always be a certain amount of work which is so variable that hard-and-fast lines, or special machines and processes, cannot be adopted.

# THE TESTING OF STEAM ENGINES.

*By Capt. H. Riall Sankey and C. Humphrey Wingfield.*

Captain Sankey and Mr. Wingfield review, with admirable conciseness, the development of engine-testing practice, and present very clearly its mechanical aspects and its practical importance. The study is very interesting in its exposition of the fact that the use of electric power has furnished both the demand and the means for the more accurate testing of steam engines.—THE EDITORS.

ALTHOUGH the systematic and accurate testing to which practically every steam engine is now subjected dates only from the commercial use of the dynamo, tests of some sort were carried out in the very earliest days of steam-power practice.

In 1774 Smeaton tested a Savery steam pump, and found it raised 100 cubic feet of water per minute to a height of 14 feet with a consumption of 3 hundredweight of coal in four hours. In working out the result he gave the "duty of the pumping plant" as "5,250,000 foot pounds of work per bushel (84 pounds of coal.)" In modern units this is equivalent to about 32 pounds of coal per hour per effective horse power.

About the same period Smeaton made many trials of Newcomen engines which gave duties varying from 3,250,000 to 7,500,000 foot pounds per 84-pound bushel of coal. As these engines appear to have been used exclusively for pumping purposes, it was natural to take the pump power as the measure of work done, and this was adopted by Watt also for pumping-engine trials. Indeed, the practice of stating the work done by a pumping engine in millions of foot pounds of work developed while burning a given weight of coal has continued to the present day.

Watt's engines were in demand for general power purposes where horses had previously been employed, and he often had to guarantee that a proposed engine would satisfactorily replace a given number of horses. Savery, in 1712, had estimated that a pump developing 3,080 foot pounds per minute was equivalent in power to one horse. Smeaton ascertained that about 22,000 foot pounds per minute might be taken as the average work of an ordinary horse. Watt, however, felt that he could not base guarantees on an average result, so he experimented [1784] with a powerful London dray

horse. He found that it could do work at the rate of 33,000 foot pounds per minute, a unit ever since known as "the horse power." He appears, however, to have used this unit chiefly for commercial purposes, still expressing the results of trials in terms of millions of foot-pounds duty per bushel of coal.

Independent Testing of Steam Engines.—As pointed out later on by Mr. Mair,* "an engine uses steam and not coal," but it was not till the middle of the nineteenth century that this began to be realised and that engineers made attempts, when testing the efficiency of engines, to avoid confusing the issue by including in the final efficiency that of the boiler.

J. Farey [1849] compared the steam consumption of two engines by noting the temperature of the discharge from a jet condenser.†

G. A. Hirn [1856] suggested as a general principle in engine tests the comparison of the heat supplied to the engine with the heat rejected to the condenser. This principle is the foundation of the modern system of accurate engine testing.

W. B. Farey [1868] described a calibrated "tumbling bay" or weir for accurately measuring the quantity of water discharged per minute from a surface condenser during an engine trial.‡

Mr. Emery [1874-5] conducted some very careful steam-consumption trials on the American steam vessels "Bache," "Rush," "Dexter," "Dallas" and "Gallatin." The start feed water was measured by two calibrated tanks which were filled alternately, the feed being pumped from the one last filled.¶

Michael Longridge [1880] made a very complete trial of a compound engine, and expressed the results as a "heat balance."§

The same experimenter [1881] tested a horizontal compound engine at Blackburn. On this occasion Hirn's methods were applied for probably the first time in England, and a very complete heat account was given. The measurements of feed and condensed steam were by measuring tanks and tumbling bay respectively.**

* *Proceedings of the Institution of Civil Engineers*, XCIII, p. 203. *Engineering*. XXXVII, p. 154.

† *Engineering*. VI, p. 58.

‡ This apparatus was afterwards described in great detail on p. 97 Vol. XIX of *Engineering*, where the method is given of calculating from observation the number of B.Th. U. carried off by the exhaust steam per indicated horse power—a quantity which was called "the constant" of the engine tested.

¶ *Engineering* XIX, pp. 14, 129, 133, 153 and 177. Summary of trials XXI, p. 124. An engraving of the measuring apparatus appears on p. 139, Vol. XIX, *Engineering*. The original report of these trials by Messrs. Emery and Loring appeared in the Report of the U. S. Treasury Department, Washington, D. C., Nov. 4, 1874.

§ *Engineering*, XXXI, p. 166.

** *Engineering*, XXXIII, pp. 174, 220, 242 and 266.

J. G. Mair [1882] published the results of testing a number of engines independently of the boilers, the trials being conducted on Hirn's principles. The air-pump discharge was led into a tank from which it escaped through a submerged hole, and the rate of flow was measured by the height at which the water stood above this hole, the equivalent rate having been found by trial. The feed was passed through a measuring tank.

P. W. Willans [1888] read his first paper on "Trials of a Non-condensing Steam Engine," in which he described the methods of steam-engine testing which he had devised for use at Thames Ditton. He introduced the plan of weighing instead of measuring the water; using a single tank large enough to contain the whole of the water required for a given trial, which was mounted on the platform of a weighing machine and connected to the feed pump by a flexible pipe. This tank having been filled and balanced, the sliding weight on the steelyard of the weighing machine was set to correspond with the weight of water which would be left in the tank when a pre-determined amount had been pumped into the boiler. As soon as this amount had been withdrawn by the pump, an electric bell was rung by the falling of the steelyard and the pump was stopped.

The method of weighing is more accurate than that of measuring, as it is difficult to hit off the exact height of the water in a measuring tank. Although it may be assumed that this error is as often plus as minus, it is possible that this may not be so, and in such a case the cumulative errors of the large number of measurements taken during a trial might be considerable. By substituting one weighing for a number of measurements, Willans eliminated this source of error entirely. As losses through leakage and weeping at the safety valve were not directly accounted for by measuring the feed, separate trials were made to ascertain their amount and the gross weighing corrected accordingly.

Although very great accuracy was thus attained, the corrections were laborious and required considerable skill on the part of the observers. Mr. Willans therefore abandoned the plan of weighing the feed, and thereafter adopted that of condensing the exhaust steam and weighing it instead. Where it was desired to run at atmospheric pressure, the air pump was disconnected and the flow of circulating water to the surface condenser adjusted to give the desired back pressure; the water being led direct to the tank through the nearer of the two pipes in the engine.

In the course of the discussion of a paper (1891) by Mr.

Crompton on "The Generation and Distribution of Electrical Energy," Mr. Willans published* his discovery of what is known as the "Willans' law," viz., the fact that part of the steam used by a given engine running at constant revolutions and expansions varies directly as the indicated horse power, the remainder being constant at all loads.

In his second paper,† read after his death, Mr. Willans used this law as a powerful instrument for interpreting the results of the trials of a condensing central-valve engine. Greatly improved methods were described, the principal departure from those given in his previous paper being the substitution already referred to, of weighing the exhaust steam instead of the feed water. Instead of setting the steelyard to indicate the gross amount of steam to be used during a trial, the tank was first balanced and the sliding weight then adjusted to indicate a comparatively small additional amount, for instance 100 pounds. As soon as the steelyard indicated, by ringing an electric bell, that this weight of condensed steam had reached the tank, the time was noted, the weight pushed forward another 100 pounds, and so on to the end of the trial. In this way a number of points were obtained on a consumption curve, and a very satisfactory check obtained on the final result. So extremely accurate has this method proved, that it is found the results of a 20-minutes trial give the steam consumption as exactly as a trial of several hours duration.

The establishment [1888] of a test house as part of an engineering works, in which all the necessary instruments and means of using them were provided, marked a very great step in advance of previous practice, and it is probable that Messrs. Willans & Robinson's works at Thames Ditton were the first to be so provided. The testing of an engine is thus reduced to a routine; no test stands by itself, but forms one of a series; the assistants are specialists, and any error is at once detected by comparison with similar cases. Other firms soon followed the example thus set, and it is now becoming exceptional for an engineering works to be without its test house.

As one of the most modern examples, the description of that erected at Rugby by Messrs. Willans & Robinson will be of interest. Engines to be tested are placed on trucks and run direct from the erecting shop to "the test," where electric travellers take charge of them and place them where required.

Steam is provided by a battery of four Niclausse boilers (Figure

* *Proceedings of the Institution of Civil Engineers*, CVI, p. 61.

† *Proceedings of the Institution of Civil Engineers*, CXIV, p. 2.

2), of which as many as are required for the tests in progress are connected to a main steam pipe which runs along the side of the building at the back of the engines at a convenient height. Another pipe, parallel to this but at a lower level, contains water kept under pressure by a centrifugal pump, which is used for circulating purposes in the condensers. During an engine trial the pipes marked "condenser discharge" in Figures 3 and 4 are connected to other pipes, sunk in the floor, which serve to carry off the waste circulating water to a cooling pond and to conduct the condensed steam to the weighing tanks.

There are two of these tanks, one of which is seen in Figure 3, and by using them alternately a continuous test can be made extending over any number of hours. The condensed-steam pipes terminate immediately over these tanks, and three-way cocks are provided so that the water from either system of pipes can be directed into the tank desired through bent pipes, one of which is shewn in the figure. The steelyards connected to the platforms on which these tanks stand are in the adjoining weigh room, a view of which is given in Figure 5.

The consumption is measured by an assistant standing at the table seen in the figure, above which is the dial of a standard clock. All being ready, and the engine, condenser, etc., connected to the nearest branches on the several pipes already referred to, the engine and dynamo are allowed to run until temperatures, output, etc., are normal. The assistant then slightly overbalances the steelyard (Figure 5) by means of a jockey weight, and notes the instant when the lever rises as the commencement of the consumption test. Signals by means of electric bells ensure that the records taken periodically by indicators, counters, and electrical and other instruments, are simultaneous. The method of logging the water in equal weight increments has already been described.

Objects of Engine Tests.—Scientific testing for purposes of research or for obtaining data for improvements will not be touched upon in the present article. It is proposed to deal only with commercial routine tests, made either to prove that a guarantee has been fulfilled or to obtain data for future guarantees of efficiency.

For this purpose it is necessary to measure:—

(a) The power-producing agency (heat units received by the engine).

(b) The work developed in the cylinder (indicated horse power).

(c) The effective work done, and incidentally,

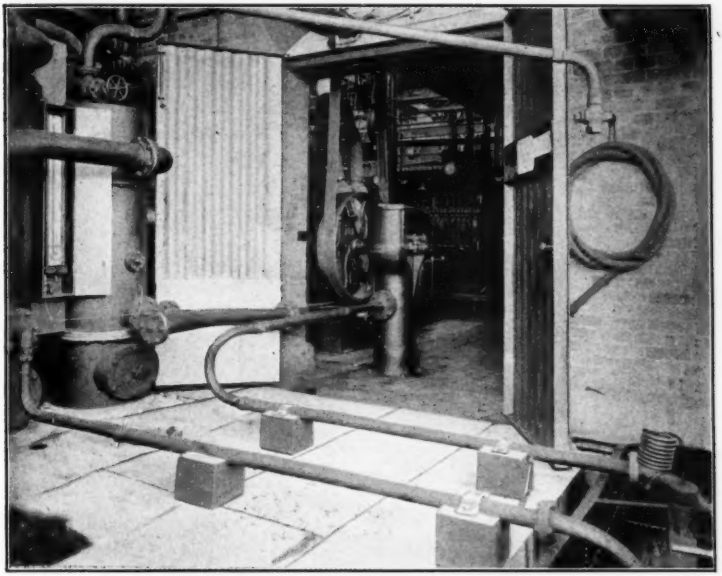


FIG. 1. THE ORIGINAL COMMERCIAL ENGINE-TESTING PLANT AT THAMES DITTON.

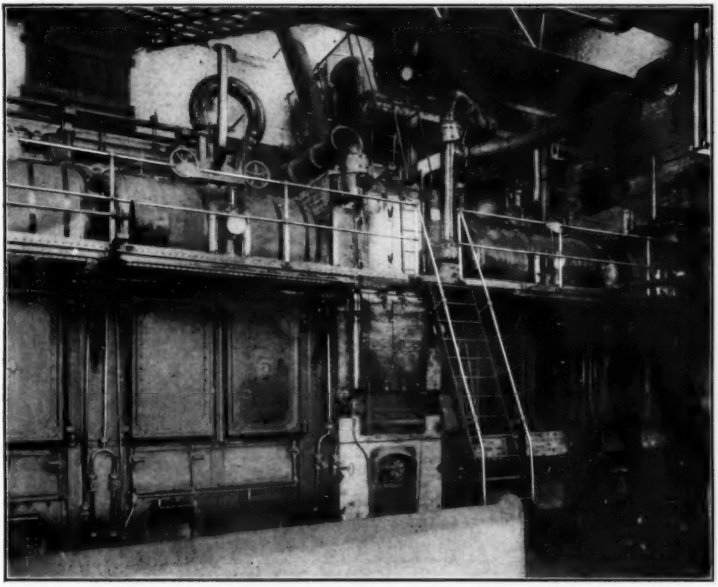
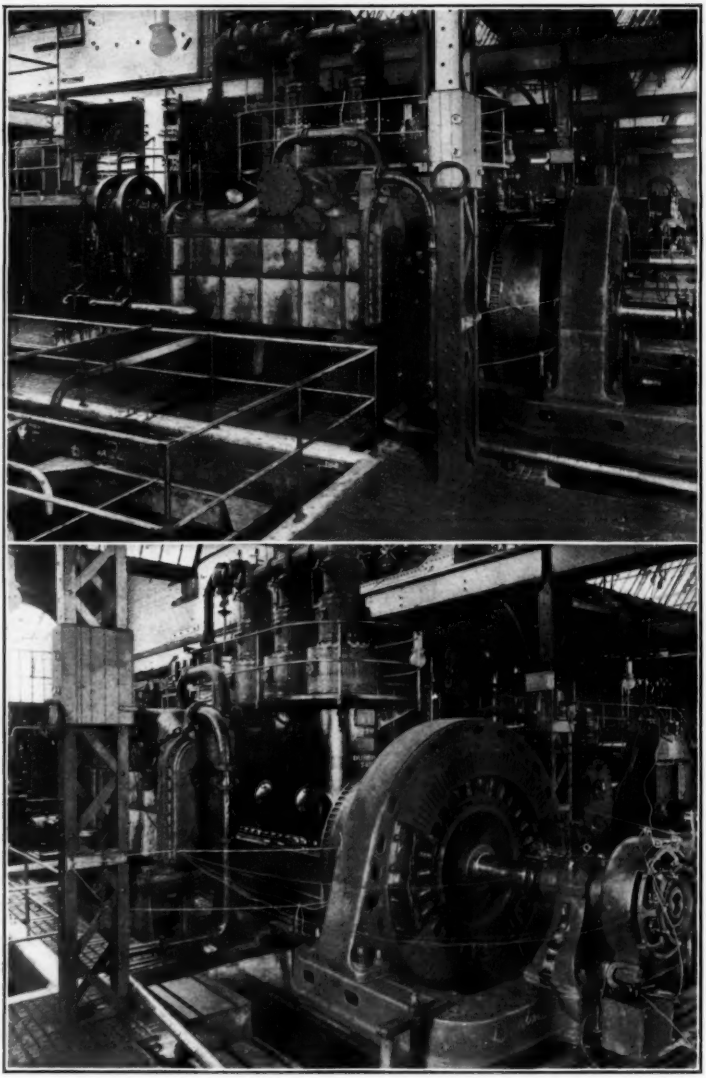


FIG. 2. BOILER HOUSE, RUGBY TESTING DEPARTMENT. FOUR NICLAUSSE BOILERS.
The two large drums near the roof on the extreme right are thermal-storage tanks on Druitt Halpin's system. The brickwork in the centre contains an independent superheater.



FIGS. 3 AND 4. AN ENGINE UNDER TEST.

Weighing tank is seen in the pit in the foreground (upper picture); the bent end of a pipe leading from the three-way cock mentioned in the text hangs over the tank; the discharge from the air pump is led direct to it by the pipe resting on the lower hand rail. The engine with two flywheels, on the left, is the air pump; the air-pump suction is clearly seen leading from the condenser. Condensers and air pumps are moved about as required by electric travelers. In the gallery at the back are the switchboards, balancing coils, and rheostats.

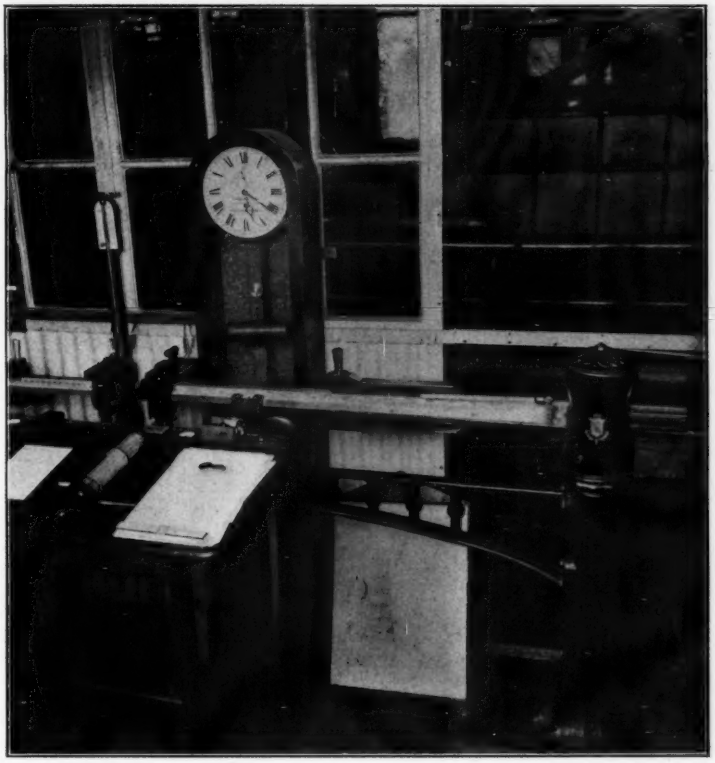


FIG. 5. PART OF THE INTERIOR OF THE WEIGH ROOM.

The weigh room is divided from the electrical-instrument room by a partition to the left of the table. The spots of light from the reflecting galvonometer are thrown on a translucent scale on a panel in this partition, and thus are seen from the table in the weigh room. The nearest steelyard connects with the platform carrying the near tank in Fig. 3. The one just seen on the left connects with a second tank. The large sliding weight keeps count of each 1,000 lb. water of condensed, the smaller one registering smaller increments. The wires leading from the contacts at the end of the lever serve to ring a bell when the steelyard rises.

(d) The work used up in driving the engine itself, which is of course the difference between (b) and (c).

Thermodynamic Measures of Energy Supplied to a Steam Engine.—As a direct measure of the heat units supplied to a steam engine is not obtainable, an indirect process has to be resorted to, and the heat is measured by ascertaining the weight of steam used in a given time and multiplying it by the number of heat units known to be contained in each pound, as shewn in the following table:—

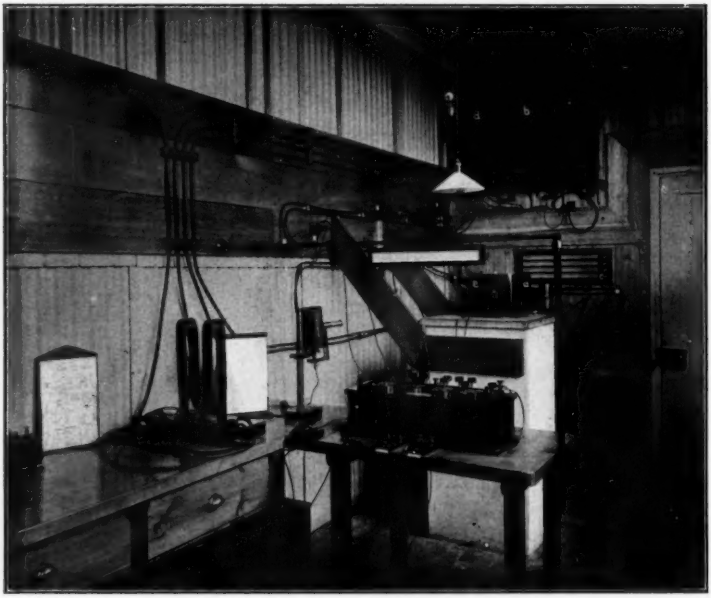


FIG. 6. THE ELECTRICAL INSTRUMENT ROOM.

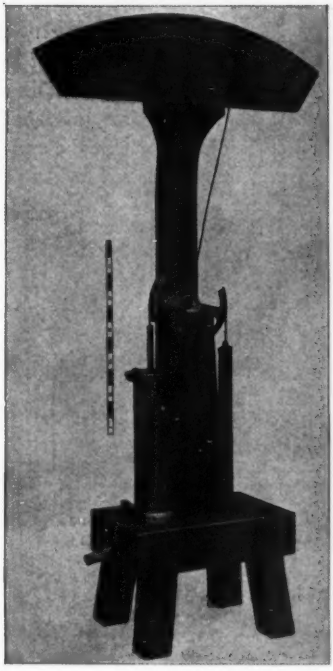
This is on the other side of the partition from the weigh room. The four translucent scales referred to on page 237 are seen just at the left of the door. Three of the reflecting galvanometers standing on the pedestal reflect onto these scales; the fourth faces the other way and reflects onto the suspended scale. Three of the illuminating electric lamps are just below the translucent scales; the fourth is more in the foreground, near the Wheatstone bridge. The M-shaped strip of metal on the left is a standard low resistance.

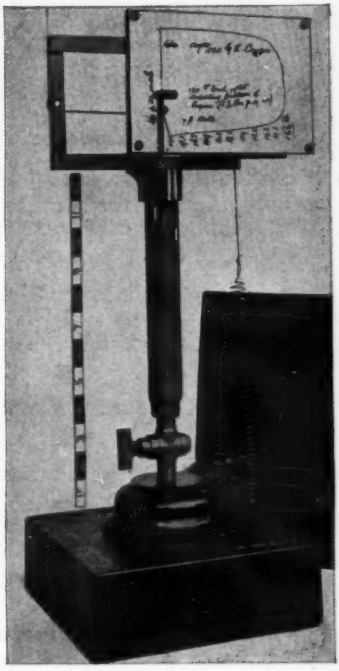
| (1) Kind of Motor. | (2) Heat Value of Fluid. | (3) Quantity of Fluid Used per I. H. P. per Hour. | (4) Data required to determine (2). | | |
|---|---|---|---|---|---|
| | | | | Condition. | Quality. |
| Steam Engine. | B. Th. U. per pound of steam. | Pounds of steam used per I. H. P. per hour. | Pounds pressure per square inch. | Wet Saturated or superheated. | Dryness Fraction. ..... Temperature. |

Until superheated steam came into use the heat units per pound of steam were so nearly constant that it was usual to compare the weights of feed water per indicated horse power without correction when judging of the relative merits of steam-engine performances. The heat value of a pound of steam now varies so largely that a committee of the Institution of Civil Engineers has recommended that either the number of British thermal units per indicated horse power

per hour should be given, or that the actual weight of steam used per indicated horse power should be reduced to an *equivalent* amount under standard conditions when reporting a trial. For this purpose a standard pound of steam is assumed to contain 1,100 available British thermal units. This corresponds to the heat value of one pound of saturated steam entering the engine at an absolute pressure of 170 pounds per square inch and leaving it at a pressure of 2 pounds per square inch (absolute).

Measurement of Work Done by the Working Fluid on the Moving Parts of the Engine.—This is invariably obtained by measuring the mean pressure exerted by the steam or other working fluid during one cycle of the engine. The instrument used for the purpose is the familiar "steam-engine indicator." It is not proposed to enter into a minute description, but it may be interesting to compare Watt's original instrument (Figure 8) with Figures 9 and 10 which shew





FIGS. 8 AND 9. THE WATT INDICATOR. THE WATT-SOUTHERN INDICATOR.

By the courtesy of *The Engineer*.

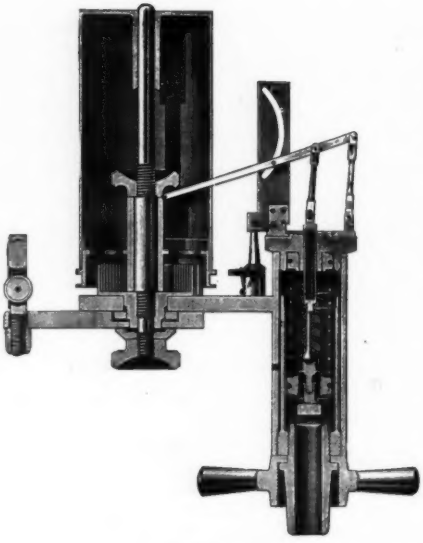


FIG. 9. TABOR INDICATOR.

two modern kinds. Even when all precautions have been taken when using an indicator, there are so many possibilities of error that it is not safe to base calculations on one set of cards only, and several should be taken and those selected which give concordant results.

There are many ways of measuring diagrams. The most exact and certainly the most convenient is by the use of Amsler's planimeter. When the needle at the end of one arm is fixed by pressing it upon the drawing board, and the style at the end of the other arm is passed round the diagram, the roller, which has previously been set at zero, indicates by the scale on its edge the area in square inches which is enclosed by the card. Dividing this area by the length of the card in inches gives its mean height in inches. As the "scale" of the spring used (i. e., the fraction of an inch which the pencil rises for each increment of one pound pressure) is known, the mean height divided by this scale gives the desired mean effective pressure. The method of calculating the indicated horse power when this pressure and the area and

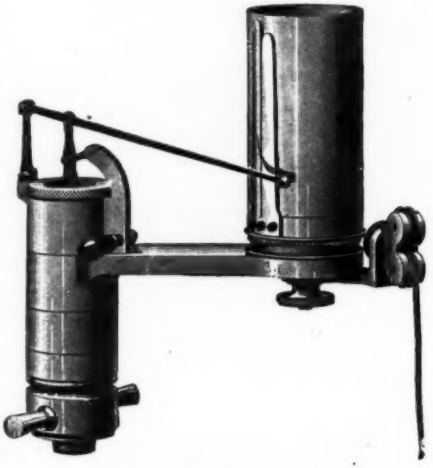


FIG. 10. CROSBY'S INDICATOR.

speed of piston are known is too familiar to need description here.

Measurement of Effective Work Done.—As already mentioned, this used to be obtained by multiplying the weight of water pumped by the height in feet to which it was raised. At the present time engines are used for a multiplicity of services, and they are usually tested by making them raise a weight at a given rate (brake horse power or B. H. P.), or drive a dynamo, the output in electrical energy being expended as electrical horse power (E. H. P.)

Brake dynamometers are usually one of two kinds—solid or fluid brakes. The simplest form of solid brake is perhaps Thompson's rope brake. It consists of a pulley over which a rope is passed, to the ends of which are attached a heavy and a light weight respectively (Figure 11). If the wheel were stationary the heavy weight would cause the rope to slide in a direction opposite to the arrow, thus doing work equal (in foot pounds per minute) to the distance fallen in one minute multiplied by the difference of the two weights. If the speed of sliding is V feet per minute, it is clear that by turning the wheel in the direction of the arrow at this circumferential speed the weights will remain stationary, the rate of sliding and therefore of doing work remaining the same. Hence the rule to find the foot pounds absorbed per minute by *any* form of brake dynamometer is first to adjust matters till the weights are balanced while the shaft revolves, secondly to calculate the velocity in feet per minute with which the weight would be raised if, instead of slipping round the wheel, the brake was clamped to it, and thirdly to multiply the weight in pounds by this velocity. Division by 33,000 reduces this product to brake horse power.

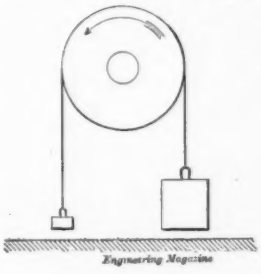



FIG. 11. THOMPSON'S (LORD KELVIN'S) ROPE BRAKE.

As an example:—suppose a weight (Figure 12) of 100 pounds hangs at a distance from the axis, which, measured horizontally, is 6 feet, and that the pulley runs at 300 revolutions per minute. The weight, if the brake did not slide, would be rising at the same rate as if the rope were wound round a big drum D of 6-feet radius. Hence the work is equivalent to raising 100 pounds at the rate of $(2 \times \pi \times 6 \times 300 = 11{,}310$ feet per minute, and the power $= \frac{100 \times 11{,}310}{33{,}000} = 34.3$ brake horse power.

Springs are often substituted for weights (as in Figure 13, for instance, which is a variation of Figure 11). The forms of brake dynamometers vary considerably but the general principle is always the same as described. A jet of water is usually kept playing on the inner side of the brake-pulley rim, and scoops remove it so as to keep up a constant circulation of water, but for very high powers it is difficult to prevent the brake and pulley becoming too hot, as will be seen when it is remembered that the whole of the work done is converted

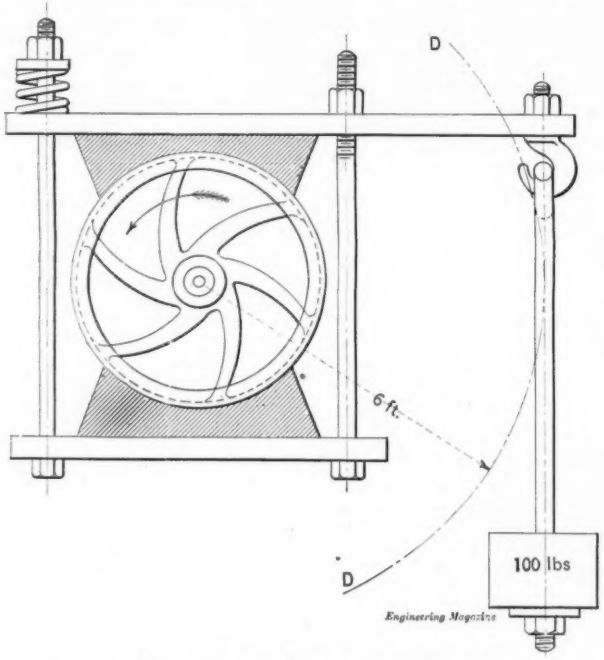



FIG. 12. DIAGRAMMATIC SKETCH OF A BRAKE DYNAMOMETER.

into heat, and a brake invented by W. Froude * is then frequently used. Figure 14 shews it connected to an engine ready for trial; Figure 15 is another view, an electric motor being under test; and Figure 16 shews its internal construction. It is something like a centrifugal pump, but the disc and sides are constructed to render the free flow of water as difficult as possible. Figure 19 shews an annular section developed, and it will be seen that the water will be dashed from the outer ends of the pockets in the disc to those in the

* A very full description appeared in *The Engineer*, Vol. XCIII, p. 616.

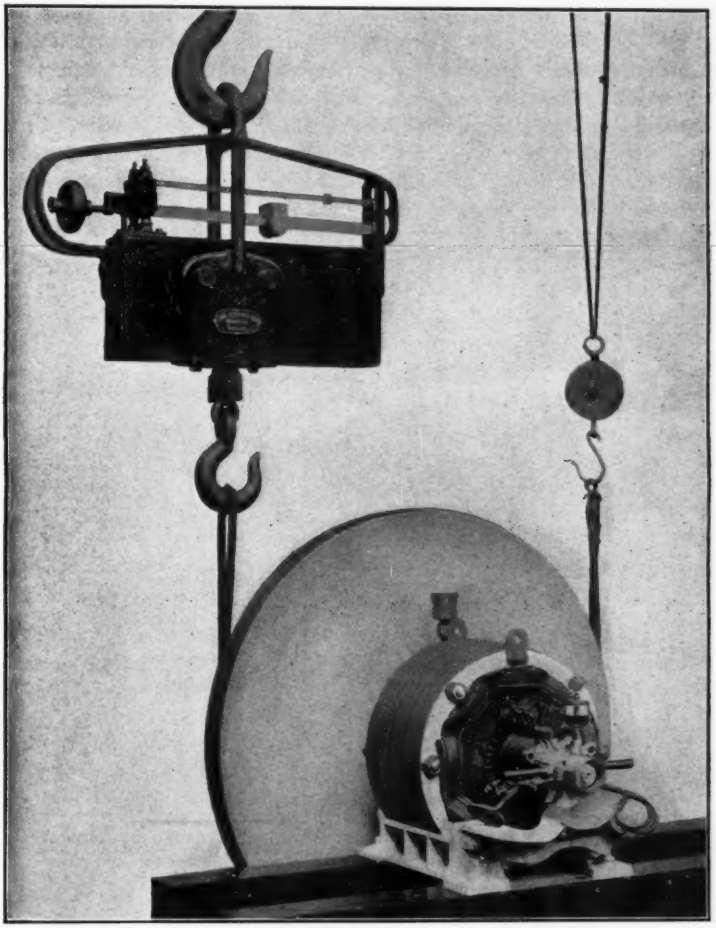


FIG. 13. A MODIFICATION OF THOMPSON'S ROPE BRAKE.

sides, in each of which it spins in a vortex and then flows back again to the centre of the disc. The consequent tendency to rotate the casing is resisted by a lever carrying a weight, as in the friction brake already referred to, the only difference being that fluid resistance is substituted for "solid" friction. The brake horse power is calculated in the same way as described above. A flow of water is maintained through the Froude brake (entering by the small holes near the cen-

tres of the divisions), which serves to carry off the heat generated when absorbing the horse power. If the rise in the temperature of the cooling water is noted it is easy to calculate how much energy is absorbed as heat by the water, if the number of pounds passing through the brake per minute are known. With the addition of the relatively small amount of heat lost through radiation and conduction through the metal, this should agree with the power measured by the lever and weight, thus forming a useful check.

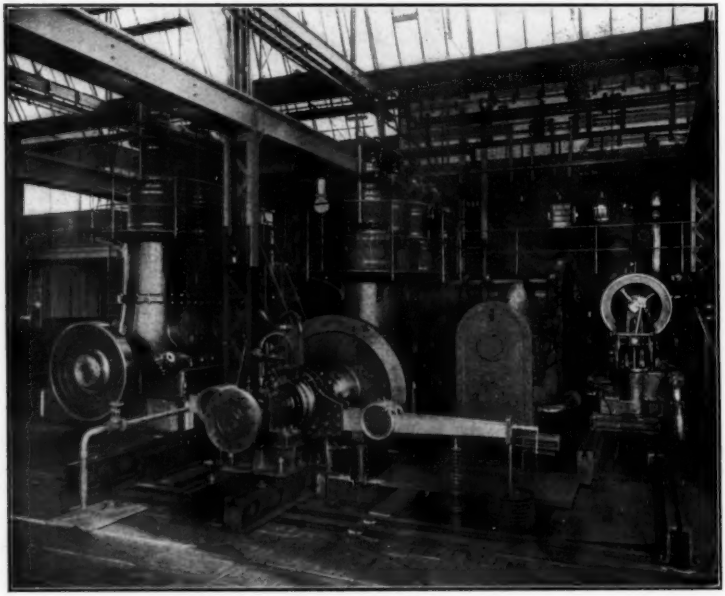


FIG. 14. FROUDE'S HYDRAULIC BRAKE DYNAMOMETER MOUNTED ON AN ENGINE UNDER TEST.

A condenser and air pump are seen to the right; the pipe to the left supplies circulating water to the brake. The spring under the beam is connected to the piston of a dashpot, and facilitates the adjustment of the sliding weight to obtain steady readings.

In cases where an engine is required solely to drive a dynamo, the latter forms a most satisfactory and accurate equivalent for a brake, when the losses in the dynamo itself have been ascertained. Moreover, it is perhaps the most satisfactory mode of testing the power of such an engine from the purchaser's point of view, since he wishes to know only what is the smallest expenditure of heat (or feed water) with which he can obtain the desired electrical horse power or number of kilowatts.

As an engine test is useless unless the accuracy of all instruments can be guaranteed, these are calibrated at frequent intervals. Figure 20 shews the apparatus made and used by Messrs. Willans & Robinson for testing pressure gauges, indicator springs, etc. Steam or

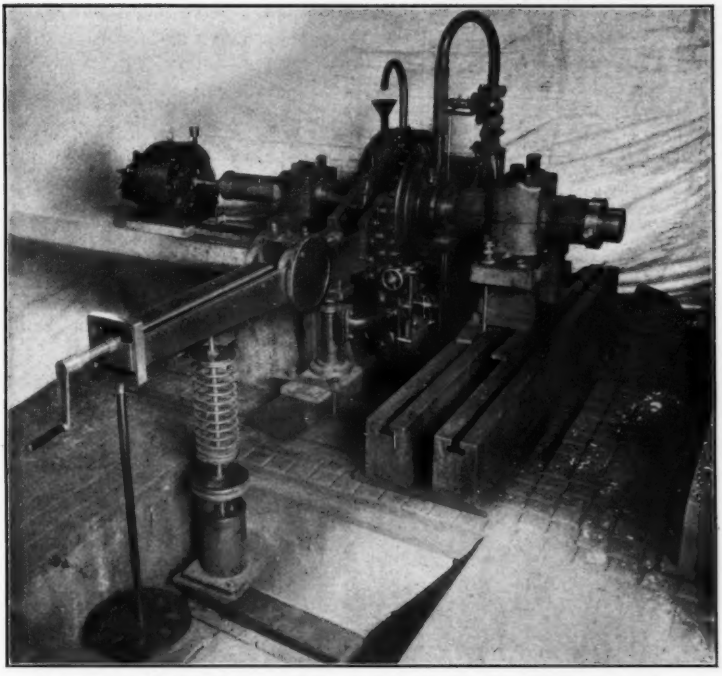


FIG. 15. AN ENLARGED VIEW OF THE HYDRAULIC BRAKE DYNAMOMETER.

Showing the flexible-tube water supply and bent-tube discharge, and the winch handle for adjusting the sliding weight. The pawls on this weight act as pointers for taking readings on scales engraved along the upper edges of the lever. In this figure the brake horse-power of an electric motor is being taken, and as this is small, the dead weights at the end of the lever, shown in Fig. 14, have been removed.

water, according to the nature of the test required, is admitted by the valve at the top of the receiver, and its pressure adjusted till the vertical sleeve, carrying the required number of circular standard weights, is just supported. This sleeve is hung from the top of a very accurately gauged plunger sliding in a vertical tube connected at its lower end to the receiver. Nozzles round the latter, fitted with cocks, serve for the attachment of the apparatus under examination.

Space will not admit of description of the thermometers, calori-

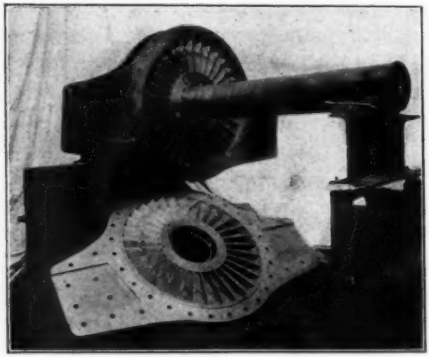


FIG. 16. HYDRAULIC DYNAMOMETER BRAKE WITH ONE COVER REMOVED.
The water enters through the small holes at the centres of the partitions.

meters, and other instruments used, but some of them are illustrated in Figures 17 and 18.

In testing steam dynamos, the current produced by the dynamo and the voltage have to be observed; the current varies from a few amperes to some thousands of amperes, and voltages vary from a few volts to 10,000 volts, provision having to be made both for continuous and alternating currents. It is evident that without very carefully designed instruments a large number of different instruments would be necessary, since measurements accurate to 1/3 of one per cent. are required.

At the Victoria Works, Rugby, the system used for the measurement of continuous currents was designed by Captain Sankey and

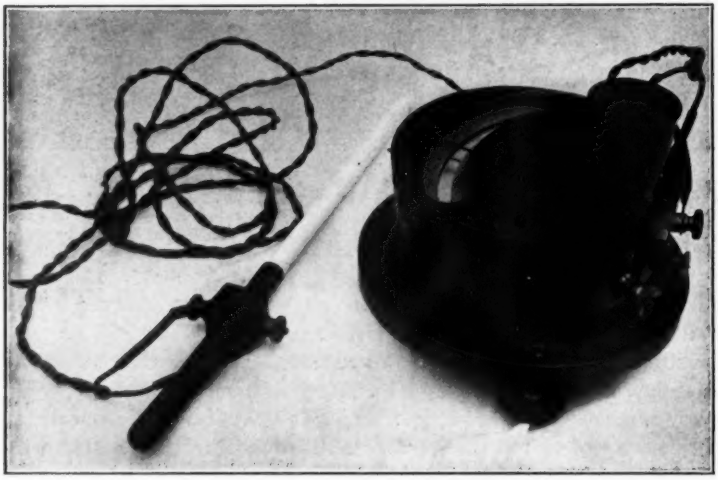


FIG. 17. CALLENDER'S THERMOMETER AND TEMPERATURE INDICATOR.
Cambridge Scientific Instrument Co.

the late Mr. F. V. Anderson, and the adaptability of one of the instruments to measurements widely different in magnitude is considerable. In measuring current the same instrument is used to measure 2,000 amperes and 1/500,000 ampere, accurate to within 1/3 of one per cent., and a similar instrument is used to measure voltages between 1,000 volts and 1/1000 volt. The system used is a direct deflection method. The current from the machine passes in its circuit through a standard low resistance of a few ten-thousandths of an ohm, which is mounted on the wall behind the gallery (Figure 22). These resistances are made of platinoid strips cast into copper terminal bars. The difference of potential across these resistances is measured, and is proportional to the current flowing, the temperature correction being practically negligible. Two potential wires from this resistance are led to a galvanometer in the instrument room (Figures 6 and 7), and in circuit with this is a resistance so adjusted that the reflecting galvanometer shews amperes direct on a transparent scale so arranged as to be seen by the assistant at the weigh-bridge. By using main resistances of different capacity and magnitude, currents of largely different value can be easily measured.

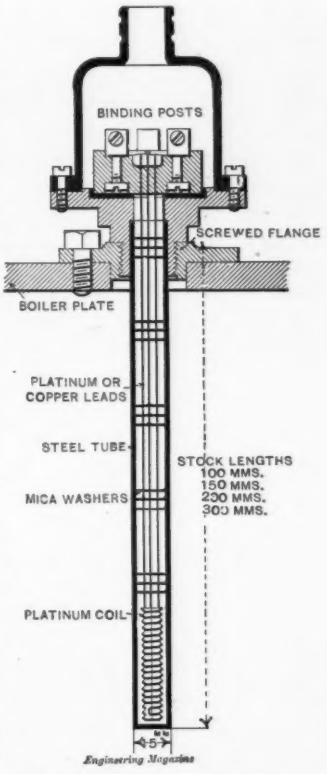



FIG. 18. INTERIOR ARRANGEMENT OF CALLENDER THERMOMETER.

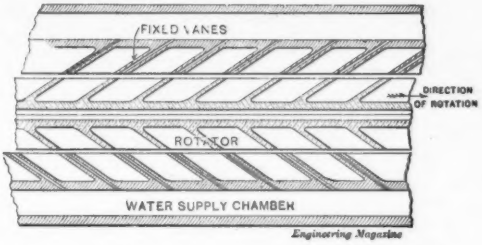



FIG. 19. DIAGRAMMATIC REPRESENTATION OF THE BLADES AND CASING OF A HYDRAULIC BRAKE.

The measurement of voltage in the case of continuous currents is done in a similar manner to that used for the measurement of currents. Two leads from the machine terminals are connected to the ends of a special resistance of 250 ohms. The potential drop caused by the passage of the current through one one-hundredth of this resistance is indicated on the galvanometer directly in volts, by adjusting a variable resistance in series with it. If the voltage of the machine be over 200 volts, two or more similar resistances are put in series. As an additional check, a Crompton potentiometer is sometimes employed.

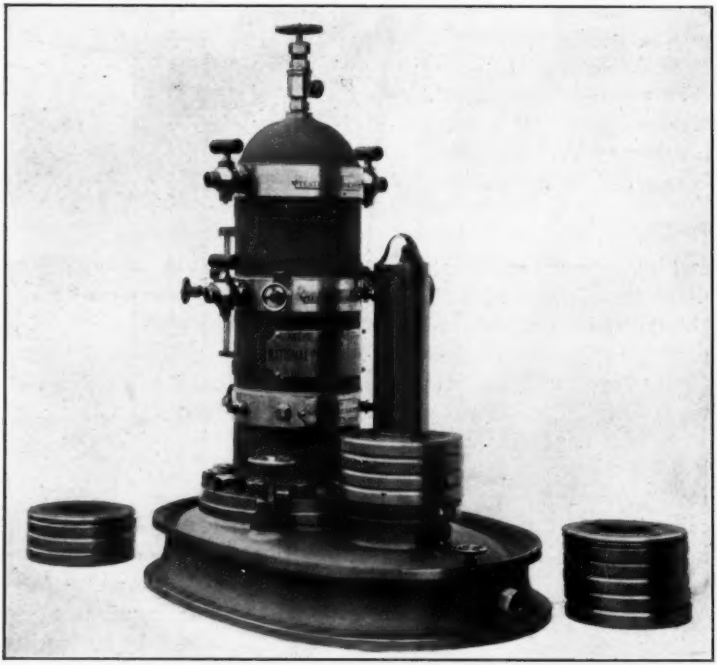


FIG. 20. APPARATUS FOR CALIBRATING PRESSURE GAUGES, INDICATOR SPRINGS, ETC.
The instruments are attached to nozzles on the vertical receiver. Steam or water is admitted at the top, and adjusted to support one or more of the round standard weights when placed on the vertical sleeve at the right, which sleeve is hung from an accurately-turned plunger of exact area, sliding in a tube connected with the receiver.

For alternating currents a complete set of instruments has been installed on the system worked out by Mr. G. L. Addenbrooke since the photographs were taken. They comprise an ammeter, a volt-

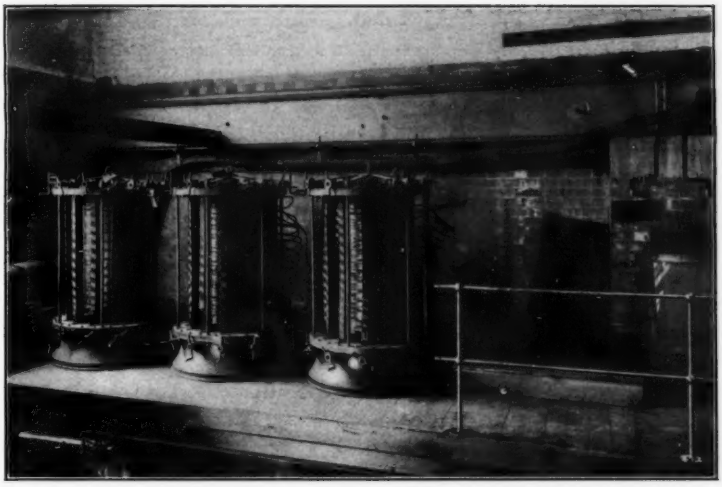


FIG. 21. GROUP OF TRANSFORMERS IN THE GALLERY OF THE TESTING DEPARTMENT.

FIG. 22. RHEOSTAT IN THE GALLERY OF THE TESTING DEPARTMENT.

meter, and a wattmeter, and are all static instruments of the Kelvin quadrant type. The wattmeter shews true watts, and from it and the apparent watts shewn by the voltmeter and the ammeter the "power factor" is at once obtained. This method, like that used for continuous currents, has been designed so that all the instruments can be calibrated by the Clark or other standard cell, this being done at regular intervals, and at any time any reading on the scale can be reproduced and its true value determined.

In order to be able to test an engine and dynamo under the conditions of ordinary working, choking coil transformers (Figure 19) have also been installed in the gallery at the back of Figure 3, so that any desired amount of induction can be put into the circuit, and the actual conditions of running can be imitated, the induction required being obtained by adjusting variable air gaps in the magnetic circuit.

The current generated by the dynamo under test is absorbed by resistances both of wire and liquid types. As these are of the ordinary pattern, no special description need be given.

# MODERN ELEVATOR TYPES AND ELEVATOR PRACTICE.

*By Howard S. Knowlton.*

Mr. Knowlton points out the intimate part which the elevator plays in the movement of modern city life. His practical study of the various types—their characteristics, advantages, and limitations—is interesting and valuable to those who are installing and to those who are using or operating, as well as those who are designing, elevator plant.—THE EDITORS.

THE development of rapid-transit facilities in large cities during the last ten or fifteen years has brought about many far-reaching changes in habits of life. Conspicuous among these are the building up of suburban communities, the cheapening of transportation to suit the pocketbook of the average citizen, the encouragement of the traveling habit, and the concentration of business in the modern office building. The telephone has had its share in revolutionizing commercial methods, as well as the subway, elevated road, and trolley car; but it is fair to charge the electric railway with the greater part of this centralization, which has found expression in the grouping of widely scattered business interests under the roof of the "sky scraper."

It is not many years since a four-story building was looked upon as a mighty triumph of engineering and architectural skill, daring to the degree of fairly tempting Providence in its defiance of established traditions. To-day a twenty-five or thirty-story structure rears its majestic pile two or three hundred feet above the city sidewalk, attracting little attention except from the rural visitor to the metropolis. The letting of a contract for a modern office building awakens little interest on the score of novelty, outside the professional and business circles directly concerned. The climbing of three or four dingy flights of stairs used to be accepted as one of the essentials of occupying "high" buildings, but nowadays even the tenant of the second-story office thinks himself hardly used if the elevator system shuts down for a single half-hour.

The modern high-speed elevator is a necessary product of increased facilities in rapid transit on the level, and of the rise of the office building. As a special case of the railway, it deserves wider interest on the part of engineers than it has yet obtained. Fortunately for the safety of the public at large, the legal restrictions which hedge about elevator practice in most cities are always tending toward the

elimination of danger. Although the best types of elevators are among the safest vehicles of travel known to man, there still remains much to be done by architects and engineers in the way of looking into the merits and defects of different systems with a view to specifying the apparatus best adapted to the conditions in each new building.

At the present time, it is generally well recognised that the requirements of elevator service are much more severe than those of railway operation. The elevator must meet very severe conditions in acceleration and retardation, running upon a 100 per cent. grade in almost continuous service for long periods of time. In high-speed office-building practice, a car weighing perhaps 3,000 pounds may have to be accelerated from standstill to a speed of 800 feet per minute in a little over a second and a half, and this without discomfort to the passengers. Any such acceleration upon an ordinary railroad track—5.5 miles per hour per second—would be practically impossible without throwing the passengers into a heap upon the floor of the car. Even 3 miles per hour per second is more than can be comfortably sustained in elevated or surface railway service. Such accelerations call for large power capacity in the motor, steam, or hydraulic plant which operates the elevator system of a modern building. The power fluctuations are perhaps more violent in elevator service than in any other application of electric motors. The effect of a shut-down in business hours proves to be a great inconvenience to all the tenants of a large building, and there is no repair shop or car house for an elevator to run into when it is disabled, as on a street or elevated railway. Fortunately, although the service requirements are severe, there is present an opportunity for constant inspection and supervision not found in transportation upon the level; the pathway of the elevator is never blocked by teams, pedestrians, and other cars, and collisions between cars of course never take place. So rugged are the best modern designs of elevator equipment that beyond daily cleaning and oiling the machinery often runs for weeks and months without the need of repairs.

Passenger elevator speeds have been classed as high, covering from 350 to 800 feet per minute; medium, covering from 150 to 350 feet per minute; and low, covering from zero up to 150 feet. Freight elevators rarely exceed 350 feet per minute, as the cost of high-speed operation is out of all proportion to the time gained in handling merchandise, just as on a steam railway it pays to move the freight traffic at a slower rate than the passenger. When it is necessary to handle light freight at high speed, it can best be done during hours when general business is slack upon the passenger-elevator equipment.

The choice of elevators for a given installation is a very broad

question, involving the careful consideration of many factors. Among these, quoting P. R. Moses, are the class of travel, distance between floors, available space, cost of labor and power, the heating system, probable relation of average to maximum load, continuity of service, and legal restrictions. Limited space in a building means that the up-and-down traffic must be handled by a few cars operating at high velocities, with all the added expense of heavy power consumption and skilled attendance to be balanced against the cost of putting in additional elevators. Here is where the need of expert engineering advice comes in. The financial problems bearing upon the elevator system profoundly affect the economic operation of the whole building, and it is a great mistake to decide off-hand upon the type of equipment to be used, or to put in a certain system on the score of personal influence without first making a careful study of the probable requirements of the new building and the operating experience obtained with different system in older structures. Too often a large amount of money is spent upon ornamental features of buildings, to the detriment of the elevator system and the rest of its mechanical and electrical plant. This condition of affairs is rapidly adjusting itself, however, to the demand of tenants for the best equipment, so that the rental power of a new building depends very much upon the convenience, safety, and reliability of its lighting and power service.

In comparing the relative merits of hydraulic and electric elevators many points must be borne in mind. The very general availability of electric current supplied from a central station makes it possible to employ this means of power to drive elevators where no other source of power is readily available. Advocates of the hydraulic machine claim that for light loads and comparatively slow speeds, calling for not too large a horse power in machinery, the simple motor-driven elevator is very satisfactory and also economical, but when speeds of 350 to 800 feet per minute are reached, the heavy loads and necessary rapid acceleration and retardation demanded by modern office-building service involve serious complication in the controlling machinery. It is not my purpose to favor either type to the exclusion of the other, but to point out some of the striking features of each class which must be taken into account in deciding upon specific installations.

In passing, mention may be made of the fact that steam-engine-driven passenger elevators have been built and successfully operated at speeds as high as 400 feet per minute, and that these machines often fill a useful place in situations where electric current is not readily available. For freight service the steam hoist has long been favored,

but no steam-driven elevator machinery can boast upon the score of economy, and for this reason electric or hydraulic hoists are coming more and more to supersede the steam-driven elevator.

Purely electric elevators are now almost entirely of the drum type, driven by a motor through a single or double worm gear. Seven or eight years ago the screw type of electric elevator commanded great attention in the engineering world, and a large number of installations of this type were made in new office buildings. The mechanical and electrical features of this type were of marvellous ingenuity, and the safety of the apparatus was unquestioned. A motor was direct connected to a screw shaft which carried sets of multiplying sheaves along the shaft upon a ball-bearing nut; the limit of travel was absolute and fixed; the controlling switches and rheostats were operated by a beautifully designed differentially wound pilot motor; the elevator came to a stop the moment the operator's hand left the switch in the car; the elevator was raised by power and lowered by gravity—the motors acting as generators and returning power to the line, braking the descent; and the comfort of the passengers was notable. Unfortunately, the equipment was very complicated; depreciation was high—over 12½ per cent. in a Massachusetts office building known to me; the starting currents were so prodigious as to flicker the lights all over the building to a degree that demanded the installation of an expensive storage-battery booster, and controlling apparatus to take up the terrific current fluctuations; and so, in spite of its many admirable features, this type went to the wall, and if I am correctly informed, is no longer manufactured. For a building but a few stories in height, where the cost of electric power is low, and very high speed is not necessary in handling a heavy traffic, the simple worm-driven electric machine has an almost impregnable field. "The worm-gear drum elevator is not fitted for the heaviest, fastest, and longest travel service of to-day, however, as its movement is endless in its character, and cannot have double or triple ropes on the drum on account of space limitations, and the impossibility of equalizing the work on the machine." Buildings but a few stories in height do not require as high-speed elevator service as taller structures, and for this reason the purely electric elevator has enjoyed great popularity in the far Western States, where very high office buildings are less common than in cities like New York and Chicago.

Safety is the prime requisite in every kind of elevator service. Danger to life must be avoided at the sacrifice of every other advantage. In no case is this more true than in residences, hospitals, and those apartment houses which dispense with the services of an ele-

vator attendant. To meet the requirements of this service, electric elevators are now on the market in which the control and operation is reduced to the simplest conceivable terms, so that accidents cannot happen through the ignorance or carelessness of women and children. In this system a passenger desiring to use the elevator presses a button placed near the elevator shaft, and the car, if not in use, immediately travels to that floor and stops automatically. When the car has come to rest at that floor, the door can be opened. The passenger then enters the car and closes the door. Unless the door is tightly closed the car will not leave that floor. Inside the car is a series of push buttons, numbered to correspond with the various floors. The passenger pushes the proper button, and the car proceeds to the desired landing and stops automatically. Not until the passenger has left the car and closed the door can the elevator be controlled from any other floor. Should the passenger desire, for any reason, to stop the car at any point of its travel, he can do so instantly by merely pushing the safety button with which the car is provided. This type of elevator is so easily and safely operated that any member of a household can be trusted to control it.

An important advantage in certain types of electric elevators is found in the ease with which the driving apparatus may be installed at the top of the hatchway, where ordinarily the overhead sheaves would be placed. Much valuable basement space may be saved in this way. Then, too, the electric elevator motor usually takes power in proportion to its load, whereas all ordinary forms of hydraulic machine require full power for all loads, whether minimum or maximum. Efficient counterbalancing is very difficult with the hydraulic elevator; there is no return of power on the down trip to assist other elevators in ascending, and the power-generating plant of the hydraulic elevator must preferably be independent of the lighting plant, which increases the cost, adds complications to the arrangement of apparatus, and reduces the fuel efficiency. Then, too, the ordinary pumping plant is wasteful of fuel, while the more efficient types are so expensive as not to be justified except in very large plants. This last point is somewhat modified in the case of a steam-pumping plant in which the exhaust steam is utilized for heating purposes, and as far as actual cost of running is concerned, where a steam boiler is maintained for heating, hydraulic elevators run by a steam pumping plant are probably as economical as any system which can be named. As for the necessity of maintaining a separate plant, the requirements of elevator service are so severe that it is very doubtful in the case of electric elevators whether they should be run in connection with any electric-lighting

system, the violent fluctuations being detrimental to the steadiness of the incandescent lamps. If storage batteries are used to take up the effect of these sudden demands, the additional first cost and subsequent maintenance charges are very heavy.

The relative cost of running the two types of machines varies with local conditions. Where the quantity of water to be pumped is sufficient to warrant high-duty pumping engines built with Corliss valve gear, the cost of pumping the water is brought down so low as to make the cost of running less than current can possibly be supplied for; but where ordinary duplex pumps are used and electric current can be supplied very cheaply, the electric cost generally runs lower. An interesting point which makes for economy in the operation of electrically controlled elevators of the best design is the iron-clad reinforcement of the magnetic circuits of the solenoid switches.

An important feature of hydraulic elevators is found in the pressure tank, which supplies water under a pressure varying from 150 to 800 pounds per square inch to the cylinder or plunger which operates the car. Generally, in types which adopt the higher pressure, great economy in space is secured, but practically all forms of hydraulic elevator with which I am acquainted—with the exception of the plunger type—operate the car through the medium of wire ropes connected with a piston operating in a cylinder under heavy pressure. The motive power which shall be chosen for pumping the water into the pressure tank may be steam, electricity, or gas, depending upon the conditions peculiar to each installation. The pressure tank relieves the system of the severe fluctuations induced by the quick acceleration against gravity encountered in the starting of the car. The piping must be of extra heavy construction to carry safely pressures as high as 600 to 800 pounds per square inch.

The elevator problem is not so much the movement of heavy loads at high speeds, but is rather a problem of control, i. e., the rapid starting and stopping of these loads without unpleasant sensations to the passengers. A carefully graduated hydraulic valve controls the flow of water to a nicety. In the case of stopping an electric elevator (and it is the stopping of any elevator that offers more complications than the starting) it is practically a question of shutting off all at once and controlling the further movement of the car by electric brakes. This introduces complications into the machinery, which requires careful adjustment and is subject to frequent derangement. In the case of the hydraulic elevator, on the other hand, the valves can be adjusted once for all and nothing whatever can occur to derange the adjustment, so that in these respects hydraulic machines

are characterized by a simplicity and reliability which is absent in electric elevators. It must not be forgotten, however, that the maintenance problem of even the simplest forms of hydraulic elevator takes into account the auxiliary apparatus of the pumping system, which includes a number of valves, pipes, pump parts, and some form of driving machine. In large plants especially, it is often more convenient to place the pressure tank in the attic, or upon the roof in climates where the water will not be exposed to freezing weather.

Within the past year or two the plunger type of hydraulic elevator has come to the front for high-speed office-building service. It consists of a cylinder set vertically in the ground directly under the car, and of a length equal to the run of the elevator. In this cylinder works a plunger of the same length, carrying the car on its top. The plunger is made of steel tubing of suitable size to raise the required load with the available water pressure, the diameter ranging usually from 4½ to 8½ inches. The cylinder is built up in sections of a steel pipe one or two inches greater in diameter than the plunger, and is fitted with a stuffing box at the top through which the plunger runs. Water is admitted to and discharged from the top, the annular space around the plunger furnishing a passageway. The water supply is governed by a three-way valve, which is in turn operated by a pilot valve connected with the car lever. The water pressure commonly used varies from 140 to 200 pounds per square inch.

Several points in regard to this type of elevator are of special interest. It is absolutely safe from falling, as the car is always supported from beneath, and not suspended from above by ropes. The mechanism of the elevator proper is simple, with little to wear except the packings and guide shoes, which are easily renewed. The power is exerted directly, securing high efficiency and freedom from vibration. Valves entirely independent of the main controlling valve are provided to bring the car to a gradual stop at each end of its travel. When the run of the car exceeds 25 feet, a counterbalance is generally used. The plunger always rests upon a column of water which can escape only as it is driven out of the cylinder through comparatively small openings, and further protection against accident is found in the fact that the steel plunger would bend to the side of the well room without being put under dangerous stress. The car cannot be made to shoot up to the top of the well room, and it cannot attain a downward speed that is unsafe because of a special throttle valve which is introduced into the exhaust pipe. There are no machine parts or pipe connections below the ground; the cylinder is well protected, and has been found to be long lived in at least 20-years' ex-

perience with slow-speed plunger-type elevators. The economy of space is also noteworthy. Owing to the fact that a cylinder of equal length to the car travel has to be sunk in the ground, the nature of the soil has an important bearing upon the cost of installation.

Although brakes are in common use upon electric elevators, they have never been successfully employed upon hydraulic machines except as emergency appliances. The problem with long-run elevators is to stop them within a reasonable distance, which may be assumed to be a little less than the distance between the floors of a building—say 8 to 10 feet—a limitation that is imposed in part by the signal service. An upward-moving plunger elevator depends upon the action of gravity alone to bring the car to rest. The distance within which an elevator can be stopped depends upon the relative amount of counterweight carried and not upon the absolute weight of either car or counterweight. In practice it is found generally advisable to limit the amount of counterweight to about 75 per cent. of the combined weight of car and plunger, for however nicely the valve is graduated it is almost impossible that the elevator itself should not receive some accelerative effect from the water admitted during the closing of the valve.

The best elevator system for adoption is that which is safest, and in so far as is consistent with the conditions, most comfortable to passengers, quick and easy in operation. As in most engineering problems, the solution must be in the nature of a compromise. A point to be borne in mind is the elevator load factor of the building, which rarely exceeds 50 or 60 per cent., and generally runs at half of that in the busiest office structures. High speed and economy are more r less opposed to one another, so that in figuring the cost of operation it is well to realize that a slight reduction in velocity cuts down expenses very materially. It is most essential to submit all known operating conditions to bidders, and to go over the entire problems of transportation within the building at hand as thoroughly as a reliable consulting engineer advises. When the system begins to operate, data should be regularly kept to show the running expenses of each elevator, depreciation, repairs, etc. Above all else, safety demands the closest inspection, and must outweigh all other advantages in the choice of the system to be used. It is probable that the speeds of the future will not be greatly in excess of those of the present, and that as the years go by, elevator accidents will grow farther and farther apart, thanks to the interest of the engineering profession in this important mechanism of transportation.

# A DEVELOPMENT OF RECENT MACHINE-SHOP PROCESSES.

## THE PRODUCTION OF INTERCHANGEABLE WORK IN THE GENERAL SHOP.

*By Wm. M. Barr.*

MACHINE shops are divided into two general classes—shops in which things are made, and shops in which things are manufactured. Both are necessary to the proper development of machine industries; each has a field peculiarly its own, and each may be of the highest order in equipment, utility, and commercial importance.

A marine-engine shop is a good example of a shop in which things are made. It rarely happens that marine engines are duplicated. The design, materials, and workmanship must be of the best. Many of the parts require to be interchangeable, and they must be made so without the employment of jigs or other permanent fixtures which might be rendered useless upon the completion of the work in hand. Marine-engine work is therefore taken, in the following pages, as the source of a few examples showing how interchangeable work may be produced with the ordinary general equipment of a "non-manufacturing" shop.

Duplicating should be carried to the utmost limit, as it greatly simplifies work in the drawing room, pattern shop, tool room, and the machine shop. Patterns for special work (unlike those for standard work, which demand the best of material and workmanship) may be made in the cheapest way, from ordinary lumber costing less than half as much as standard pattern lumber. The parts may be nailed together, the fillets made with putty, and the whole given one or two coats of black varnish to prevent the sand from sticking to the pattern. It is common in patterns of this kind to allow a little extra thickness of metal where the parts are to be fitted. If core boxes are required for such patterns, they can be made in the same temporary manner as the main pattern. Both pattern and core-box material can be afterwards used for boxing or other rough use about the works. A sweep can be employed to advantage in many cases, the necessary projections being introduced into and attached to the mould, and the

pattern being withdrawn when the mould is ready for drying. Swept-up work may also be done by straight edges as well as by curved formers, depending upon the design in hand. The interior core is usually built up in brick covered with loam, and inserted in the mould in guides provided by the main sweep.

Steel castings can be made to take the place of forgings in many cases at a very considerable reduction in cost. The greatest care must be exercised in designing and proportioning steel castings to avoid thick parts and thin connections. The thin parts will cool much more rapidly than the thick parts, and are liable to open up a seam along the line of the light web or projection.

A shop of this kind will include as a necessary part of its equipment, massive lathes, planers, vertical and horizontal boring machines, slotting and shaping machines, and, in addition, a large cast-iron floor plate upon which the work is fastened to be operated upon by portable facing, slotting, milling, boring, drilling and tapping machines, as may be required. These will be independently driven by electric motors attached to each machine. Portable drilling machines driven by an endless cord can be used to good advantage on heavy castings even though the works be fitted with large radial drilling machines.

A well equipped tool room is as essential to economy here as in a highly organized manufacturing establishment. A complete set of standard gauges, as well as drills, taps, and reamers up to 3 inches diameter will be provided, and special ones, as may be required, up to 4 inches and sometimes larger. Steel measuring rods will be found much more satisfactory than the use of a steel tape for all length below 8 feet; these rods may be 5/16 to 5/8-inch square, depending upon the length, the ends tapered, hardened, and ground to exact length; these can be used for transferring dimensions by calipers, as well as by direct use. Plugs and rings above 3-inches diameter may be made of cast iron and insure all the accuracy needed in occasional work.

There are certain standards which should be adopted in every manufacturing establishment and used in all cases where they are applicable to the work in hand. This is especially true in the case of screw threads, which should be of the United States standard, or correspond with the accepted standard for pipes. Special screws necessitate special taps, and are otherwise objectionable. Flanges should be made to conform to those adopted by the several engineering societies, or, at least, they should be uniform throughout the establishment.

Simple cast-iron drilling templets, even when made of considerable size, will ordinarily pay for the making. In general, but one cast-steel bushing is needed, being transferred from hole to hole as required, the inner diameter conforming to a suitable diameter of drill selected for a tap, reamer, or the clearance for through-going bolt. Through-going bolts with head and nut should be used wherever practicable, because the drilling is of the simplest character, and the bolts and nuts can be purchased at prices lower than in the case of tap bolts or standing bolts. Tapping into cast iron should not be resorted to if the bolts are to be frequently removed, inasmuch as cast iron is a brittle material, and the frequent removal of a bolt will soon impair the strength of the thread in the casting. A much better plan, but one which is not always practicable, is to insert standing bolts.

The preparation of general and detail drawings is essentially the same, whatever the type of shop in which the work is to be executed; but the pattern maker, in order to meet the uncertainties of shrinkage, or the twisting of a casting in cooling, makes certain allowances for finishing, which are greatly in excess of those given for standard work in a manufacturing establishment. The extra amount of material to be removed is but a small percentage of the total weight; the strength and rigidity of the machine tools employed will enable this extra metal to be removed with little loss of time over that necessary to do the work in any case. The important detail thus secured is that the finished parts exactly correspond to the dimensions given in the general design and detail drawings.

The order of precedence in which the main castings are carried through the works is not a vital one, but, in general, the more important and difficult work, such as the cylinders, is begun first, to be followed by the bed plate, framing, cylinder linings, valves, and smaller parts. The larger castings must be accurately measured, to ascertain not only whether they will finish to the given dimensions, but whether the center lines of the assembled work will conform to those of the approved design. If not, a change must be made somewhere to insure this important detail.

Bed plates made of steel castings require a more liberal allowance for finishing than is usual for cast iron; the matter of shrinkage and distortion in cooling is also more uncertain. Consequently the allowance for finishing and facing for the crank shaft brasses and caps must be generous, and a liberal allowance be made also for planing down the spottings for the supporting frames and columns. This applies also to frames made of steel castings, which vary considerably

even when cast from the same pattern, especially when of the inverted Y design.

After fitting the caps in place, the bed plate will be bored for the main bearings. Care must be exercised that the planed spottings on the top of the bed plate, to which the engine frames are bolted, are parallel to the axial line of the bearings, and that the end spottings where the bed plates bolt together are at right angles to this line; the first requirement may be secured by parallel bars, the latter by a tram inserted in a slot in the main boring bar. If the casting is not too large to be fitted on a 10-foot planing machine, all necessary horizontal and vertical planing can be done there, as well as the locating of all center lines upon the casting, which will then be marked to correspond to the centers of the machine itself. These center lines upon the framing are to be utilized afterwards when the several castings are assembled on the erecting floor, the center markings being adjusted axially with reference to the main bearings, and transversely by locating the centers of the cylinders by these points of intersection.

Crank shafts for medium and large triple-expansion engines are commonly made duplicates of each other, with coupling discs forged on. These crank shafts are forged from open-hearth steel ingots and turned to within an ⅛ inch of the finished diameter at the forge; the final finishing is accomplished at the works, to dimensions corresponding to certain steel bars with ends hardened and ground to such lengths as are called for in the drawings. These bars, having been numbered and registered, are returned to the tool room after the completion of the work requiring them, and form a part of the tool-room equipment. If a shaft is required to be hollow (and nearly all specifications call for such shafts), it is usually forged so by hydraulic pressure from a selected ingot through which an axial hole has been drilled, and in which is inserted a mandrel smaller than the finished dimensions, the shaft being afterwards bored with a drill head similar to that employed in heavy ordnance. The diameter of the hole through the crank pin or through the shaft is commonly one-half the diameter of the latter. Such a shaft combines maximum strength with minimum weight; the resistance to torsion is reduced by about 2 per cent., while the weight is reduced some 25 per cent.

Coupling discs for three-throw crank shafts should be drilled through a cast-iron templet bushed with steel. The three crank shafts must be in the same axial line, and, when bolted together, the cranks will be at angles of 120 degrees to one another; starting with the high-pressure crank, the intermediate crank will follow, and the low-pres-

sure crank will follow the intermediate one. It is necessary then that the templet accurately represent these angles. One way of accomplishing this is to mark permanently the center line of the crank pin on the crank webs, and carry this center line to the coupling discs and make a permanent mark upon each for reference. The edge of the templet having been accurately spaced at 120 degrees, no difficulty is had in drilling the bolt holes in the coupling discs, but the final reaming may be reserved until the crank shafts are put in place in the bed plate.

The engine frames can ordinarily be fitted on the ends in a large planer. After planing, the top and bottom center lines can be located and the bolt holes laid off; as all three of these are probably alike, it will be found economical to make a drilling templet with removable bushing, the same templet being used for the frames and for the main bed plate by a mere change of bushings. Where the facings occur for the reversing gear, spottings will be provided, which will be planed with reference to the center line of the cylinder.

Cylinder casings usually include the casing for the piston valve. The external facing and internal boring for the reception of the working cylinder linings can be done on a vertical boring mill; usually the larger cylinders will require that the valve casing be bored on another machine. It is desirable always that cylinders be bored as they are to be used—that is, vertical cylinders are to be bored vertically.

Pistons made of cast steel require careful measurements to see that no unusual distortion has occurred and that no lumps are present on the surface which will make contact with either head. If sufficient allowance has been made, it is well if a slight chip be taken off both sides of the piston; this can be done on a vertical boring mill before the final cuts are taken on the periphery for the insertion of the packing rings.

The piston rods will probably be made hollow and will all be of the same diameter and of high-grade forged steel; the end entering the piston will have a taper joint with a collar underneath and a hexagon nut above. This is a somewhat troublesome piece of fitting, and the cost of making a cast-iron plug and ring by which this fitting may be expedited will be well earned before completion of the work. The fitting into the cross-head being similar in construction will serve to further divide the cost. The piston rods will be finally ground smooth and to the diameter given. Metallic packing will be supplied by the maker selected.

Connecting rods will be of high-grade forged steel and made hol-

low. The upper end will be forked to span the cross-head, the lower end adapted to receive the brasses of the usual marine type. These rods will all be alike and are costly pieces to make. The tools required include lathe, planer, slotting machine, and boring machine. There is no special difficulty in the making; the work must be properly laid out in the beginning, the center lines carefully observed and the given outlines carefully followed.

The valve gear, including the eccentric rods, main links, link blocks, valve-stem cross-heads, reversing shafts, and connections, are all of forged steel and present no special difficulties. Sheet-steel templet or gauges can be used with profit in most cases, and will insure accurate duplication of parts and be found useful in future repairs.

Screw propellers will have each blade bolted to the boss fitted to the propeller shaft. The end of the shaft is turned to a given taper and the boss fitted to it. A gauge of corresponding taper should be made, so that both of the propeller shafts in the case of twin screws and their bosses shall be exactly alike. The propeller blades will fit into taper recesses in the boss and be secured by tap bolts. Templets should be made for both the central boss and the propeller blade. These may be made of sheet steel or a thin iron casting fitted to the dimensions given in the drawing.

By making the main shaft in standard uniform lengths, this portion of the work may be made standard, and all the difference in various jobs thrown into the tail shaft. Two spare pieces, one tail shaft and one standard length, will then enable a break in any portion to be repaired at any port, without demanding expensive shop work.

It is unnecessary to enlarge further upon this subject; enough has been suggested to indicate that a modern and progressive shop can, with a modern expenditure for a few simple templets, gauges, and measuring devices, build heavy work, strictly interchangeable, at no appreciable increase in shop cost.

# EDITORIAL COMMENT

THE past month has been fertile in engineering and scientific congresses, following the usual course in association with international expositions, and we have had congresses of electricity, of civil engineering, and indeed of the whole world of arts and science, with a flood of papers, some of which we have noticed at length elsewhere.

Speaking from experience in such gatherings, it has appeared to be a question whether the occasion of an international exposition is the most favorable opportunity for gatherings of scientific and professional men, if the ultimate value of the communications and reports to the technical and scientific world is included, and the same features are to be considered in this connection as exist for the exhibitions themselves.

An international exposition is a great show of the work of the world at the period at which it is made, and it passes into the record as a picture of the state of the arts and sciences at a definite stage of the world's progress. The fact that such displays attract a number of men of science and industry at a given time has naturally led to the organization of such bodies of visitors into gatherings for the interchange of opinion; but experience has shown that just as the great exhibition has developed into a sort of overgrown country fair, with a continually increasing tendency for the preponderance of the element of amusement, so the international congress has proved to be a plan for getting a great number of notable men together for the principal object of effecting their aggregation, the thoughtful discussion of existing scientific problems becoming next to impossible under such conditions.

* * *

IT has been believed by many that the international exposition has outgrown its usefulness with its increase in size, and that the natural result will be a breaking apart by its own weight, or rather bulk, so that hereafter we shall have smaller specialized exhibitions, devoted to definite portions of science and industry. In connection with these there may well be held gatherings of earnest men, devoted to the same general line of work, and prepared, not for a species of scientific spree, so to speak, but rather for a carefully prepared discussion of a certain limited number of current questions, divested of commercial influences, and conducted for the true advancement of the department of applied science under consideration, with the special object of mapping out the lines of future attack upon the secrets of Nature and the forces of the universe.

* * *

THE eve of an election is a time fraught with possibilities of the unexpected, but at the moment of writing the signs point strongly to the continuance of the present administration. This is the situation which has been discounted, apparently, in business and financial circles—discounted so largely that some reaction may be normally expected even if the results confirm the

forecast. The quiet of the campaign and the steady increase of tone in the commercial world doubtless are due chiefly to the general conviction that both tickets stand for conservative administration and policy, and that in no event would business interests be called upon to adjust themselves to any sudden or violent change. May the victorious party not misconstrue or overestimate the meaning of their victory! There are some grave economic questions demanding adjustment, and growing more and more insistent in the demand. The fact that they have not been made party issues should make it easier for both parties to agree, under the new administration, upon a method of determining and meeting the needs of the country in the matter particularly of the tariff—to discuss it as a matter of policy, and not of politics. May whichever party wins see that the election does not settle these great questions, but only place upon the winners the obligation for their wise settlement!

* * *

THE unequivocal language of the Government commission, in their report on the Slocum disaster, and the prompt removal of the officials held chiefly accountable, does a good deal to lessen the distrust into which the steamboat inspection service has fallen as a result of the incredible disclosures recently made. Until public attention was centered upon the actual conditions of the law and its administration, by the inquiries following the burning of the excursion steamer, there was a general feeling that (outside, perhaps, of the Custom House) the Federal arm was strong and the Federal eye watchful to protect the individual citizen. There was both anger and terror in the sudden discovery that bureau officials, charged with the most important and sacred duties toward their fellow countrymen, were, if not corrupt, at all events so indifferent, incompetent and immersed in senseless routine that their office was a contemptible mockery and their "work" a hideous farce. An awful price was paid for the exposure, but there is no uncertainty about the correction administered by the President. The ex-supervising inspector who was quoted, just after the disaster, as angrily exclaiming that his office was "not concerned with the wants of the public," should by this time be a good deal enlightened on the status of a Government official, and his record perhaps be helpfully warning to office-holders of the same stamp for some time to come.

* * *

IN connection with the subject of the revision of the present lax method of conducting the inspection of safety appliances on steamboats, the matter of making such inspection really effective may well demand the attention of the engineer, and the magnitude of the work is such that every possible appliance to render the work capable of rapid and successful conduct should be used. The discovery that certain so-called life preservers have been placed on the market with pieces of iron enclosed in the corks has brought up the point that the only form of inspection which could reveal such dangers would include the destruction of the article inspected.

This, however, is wholly unnecessary, since the use of the X-ray apparatus would reveal the presence of the iron most distinctly. It is suggested that every life preserver should undergo the test of X-ray examination, as well as the test both for size and for weight. The former would reveal the presence of any foreign substance, while the combination of a determinate size and weight limit would involve the question of specific gravity, and render deception trebly difficult.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

# THE TRANSMISSION OF ELECTRICAL ENERGY.

PRACTICAL QUESTIONS INVOLVED IN THE LONG-DISTANCE TRANSMISSION OF ELECTRICAL ENERGY AT HIGH VOLTAGES.

*International Electrical Congress.*

AMONG the subjects considered and discussed at the electrical congress recently held at St. Louis, the question of the transmission of electrical energy held an important position. The papers presented included treatments of the questions of construction, insulation, general design, and operation, including practical experience with such important lines as are found in southern California, where more than 40,000 kilowatts are transmitted from 150 to 200 miles at pressures of 40,000 to 60,000 volts.

In such lines naturally the principal points considered are connected with the insulation of the line at such high pressures, and among the papers dealing especially with insulation may be mentioned those of Professor Harris J. Ryan, Mr. M. H. Gerry, Jr., and M. E. Jona. The subject of long-spans was treated by Mr. Francis O. Blackwell, while the general details of high-tension long-distance transmission were treated by Messrs. Baum, Perrine, Hancock, Kelly, and Bunker.

The important elements involved in the design of such transmission lines may be considered as due to the length of the line, and to the voltage to be used, although these also bear certain relations to each other. Considering first matters relating to the distance over which the energy is to be transmitted, the important matters are those relating to the strength of the material of which the conductor is made, its conductivity, and the manner in which it can best be supported. In this connection Mr. Blackwell notes the difference between a long-distance transmission and one of moderate length.

"It is obvious that the longer a line the more reliable and substantial it must be. A plant transmitting power five miles might be shut down three or four times a year by line troubles without seriously interfering with its service. If, however, there were 500 miles of circuits instead of five, and the same number of accidents per mile occurred, the plant would be shut down every day, and the power would be absolutely valueless. Moreover, the longer the transmission line the more difficult it is to locate and correct a fault. On a five-mile line repairs might be made in an hour or two, while on a 500-mile system it would probably take a day to find the place and get the plant in operation again.

"Existing wooden pole lines have given good results and electric power has proved successful even under adverse conditions and justified the investment of greater capital in larger plants and longer power transmissions.

"The same reasons which have led the railroads to replace their wooden bridges with steel structures will ultimately cause power transmission engineers to substitute steel for wood in all important transmission enterprises. The advantages of a steel-tower construction are that it is fireproof, durable and readily admits of structures of a size and strength impracticable with wood. With higher and stronger supports for the power circuits longer spans

can be employed and the number of points of support correspondingly reduced. This fewer number of parts much simplifies the transmission system, both in construction and in operation, and permits of more expensive and reliable designs being used. The wires may be placed much farthtr apart, thus obviating the principal cause of trouble—short-circuits. The insulators may also be larger and better, both electrically and mechanically, and every part of the system can be laid out in advance, the strains calculated and the structures designed with ample factors of safety.

"The length of span to use is the most difficult question and the one into which the most factors enter. The calculation of long spans is primarily a suspension bridge problem in which all the mechanical stresses must be fully investigated."

So far as the strength of the conductor is concerned, Mr. Blackwell compares conductors of copper, aluminum, iron, and steel, and discusses the influence of elasticity, temperature, weather, span, and sag, giving curves from which the relative merits of the materials may be compared.

In considering the methods of supporting line conductors Dr. Perrine agrees with Mr. Blackwell in recommending metallic towers as substitutes for wooden poles, spans of 500 feet being considered as practicable, and this plan is also endorsed by Messrs. Kelly and Bunker.

Next to the question of supports for the line, the matter of insulation must be considered, and, with the high voltages now in use and proposed, this becomes a most important element in success. It is admitted that the experience acquired with low-pressure installations is of small avail for high voltages, and Dr. Ryan treats the problem from the viewpoint of the physicist, and deduces formulas from the elements of modern electrical science for determining the electric strains and the methods of meeting them. The practical difficulties in the matter of insulation are well discussed by Messrs. Kelly and Bunker.

"The selection of the line-insulators depends entirely upon the voltage, mechanical strength required, and the localities through which the line passes, more particularly the latter, as lines have been operated at 45,000 volts with two or three types and sizes of insulators in as many different sections. The design of the insulators should be such as to give the smallest amount of still-air space and the greatest accessibility for wiping by hand. Fog occurring at the same time or intermittent with soil, factory, or car-dust is one of the surest causes of trouble, and reduces probably, to the greatest extent, the effective commercial size and value of insulators. Upon examining a large number of insulators which had to be removed, it was found that the dust, with which they were coated, was thickest in the still-air spaces, and was as thick on the vertical as on the horizontal surfaces. It has been found that where insulators were subjected to fogs or dust alone (except sea-fog), the same number of troubles did not occur as when both appeared together. Where insulators are covered with dust, parts of each year, it has been necessary to shut down the circuit from one to three times during the dust season to wipe them clean. This can be done while in position and without disturbing them unless they are found to be damaged.

"The fact that insulators are successfully tested for high voltage before they are put up does not necessarily prove that they will not cause any trouble when on the line. Insulators which were tested for 120,000 volts water test for one minute have given trouble in less than a month after being placed on a 40,000-volt line. Other types which had stood 40,000 volts water test for five minutes have been known to be unsatisfactory for 13,000-volt city (overhead) service, though this would not hold in every city. The greatest value of electrical test for insulators before being used is to determine whether the various parts are homogeneous and whether they have been properly cemented together."

In addition to the maintenance of proper insulation upon the line there are certain portions of a high-pressure transmission which involve the use of insulated cables. The problems connected with the insulation of cables at high voltages were discussed in the paper of M. Jona, he deducing formulas for the proportion of lead-covered cables, with rubber insulation, as well as with paper and with gutta-percha. So far as the distance between the lines themselves is concerned, this is usually determined from

the maximum voltage to be expected, the usual rule being that the distance between wires, in inches, equals one and one-half times the number of thousands of volts.

"Where the cost of erected poles is high, or the right of way expensive, two circuits per pole-line should be used, and, with good wooden construction, mechanical difficulties would limit the distance between wires to at most 60 inches, which would allow a line voltage of say 50,000 or 60,000. This distance between wires is for spans not over 150 feet to 200 feet. The size of wire is determined from the load, voltage, length of line, losses allowable, etc. Five per cent. energy loss per 50 miles with 60-cycle frequency gives a line which can be taken care of, but a smaller loss should be obtained where important lighting service is had in connection with a fluctuating load. On account of the distance and pressure, a charging current, at no load, is required of the plant, which at 60 cycles and one line 100 miles long, or 30 cycles and two lines, would require a generator as large as 2,000 kilowatts, so that, unless more than this capacity had to be delivered as load, the system would not be economical. In order to be perfectly flexible, this amount of power would have to be carried over one circuit. The wire would, therefore, be large enough for mechanical reasons, and the energy loss per insulator, or per unit length, would be negligible, except, perhaps, for voltages over 60,000."

Another matter, and that one of much difficulty, is found in the provision of satisfactory lightning arresters.

"For voltages up to 25,000, the non-arcing types of lightning arresters, either with or without series resistances, may be successfully used. Above this voltage and where large amounts of energy are available, these arresters are found to be short-lived, and up to the present time no thoroughly satisfactory arrester has been presented, which does not, when interrupting the ground circuit after a discharge, injure the insulation of the line and transformers. The horn form of lightning arrester developed in Germany has been found to operate with invariable success so far as the lightning arrester itself is concerned, but, as it is interrupting the ground circuit, it draws a large arc, and oscillations are produced on the line, which in many cases have been found to have more serious results than the discharge they were installed to remove. Condensers in parallel with the lightning arresters and ingenious arrangements of arresters and resistances have been used with some success, but none of these plans may be considered to be entirely satisfactory for the highest potentials operated from the largest generated plants."

Taking all the elements of high-pressure, long-distance, transmissions into account, the papers at the International Electrical Congress form a symposium representing the latest successful practice, together with a résumé of the theoretical lines along which further progress may be expected.

## AIR IN BOILER FEED WATERS.

### THE INFLUENCE OF GASES IN SOLUTION UPON THE CORROSIVE ACTION OF WATER IN STEAM BOILERS.

*Jas. Alex. Smith—Victorian Institute of Engineers.*

ONE of the important considerations in boiler operation is the care necessary to prevent corrosion, and this has well been called the most insidious enemy of the steam boiler. Corrosion has been attributed mainly to acids or other impurities of a similar nature in the feed water, and much has been written concerning the precautions to be taken with the acid waters from coal mines and similar sources. Experience has shown, however, that the presence of gases in the water may lead to serious corrosion, and in a paper presented before the Victorian Institute of Engineers, at Melbourne, Australia, by Mr. James Alex. Smith, this phase of the question is discussed in the light of recent experiments.

It is well known that moist iron will become corroded in the presence of air, and in nearly all cases there is an appreciable amount of air contained in boiler feed water, but this fact has not always been considered in connection with corrosion. Air in the feed water means air in the

steam, and it has long been appreciated that the presence of air in the steam will affect the vacuum in the condenser, so that sufficient air-pump capacity must be provided to keep the condenser clear. Mr. Smith considers the effect of the absorbed air in the water with respect to the boiler itself, and brings out some interesting facts.

Ordinary air contains about 79 per cent. of nitrogen and 21 per cent. of oxygen, neglecting the carbonic acid and rarer gases, and is a mechanical mixture and not a chemical combination. The oxygen and nitrogen, however, are not absorbed in the same proportion by water, and according to the investigations of Bunsen, it appears that the gases absorbed by pure water consist of oxygen and nitrogen mechanically mixed in the ratio of about 35 per cent. of oxygen and 65 per cent. nitrogen, there being thus a much greater proportion of oxygen in the water than exists in the air. Similar results have been obtained from the investigations of Winkler and of the author, the relative proportions of oxygen and nitrogen absorbed by the water being also found to vary to a certain extent with the temperature.

"Water is thus selective in its action, and under no conditions of pressure or temperature can air, except as bubbles, mechanically entrained, and rapidly separating out, be absorbed. The gaseous mixture occupying the inter-molecular spaces of the fluid differs from air. This is immaterial so far as vacuum is concerned; all gases, when disengaged, obey sensibly the same temperature-pressure volume law; but from the chemical point of view the case is different, the oxidizing agent is largely increased.

"Assuming the containing vessel to be of iron, then, on the principle of least work, oxidation would initially proceed by the fixation of the uncombined oxygen released from the feed, since oxygen abstracted from water implies dissociation, the evolution of free hydrogen, and the expenditure of energy.

"Ferric hydroxide is the result of the combination of oxygen with iron in the presence of water; the iron component represents 11 parts by weight of iron in combination with 48 parts of oxygen. It may be shown arithmetically that each cubic inch of oxygen at atmospheric temperature and pressure is capable of reducing 0.84 of a grain of iron to rust, or, in other words, the free oxygen found in each pound of pure, atmospherically saturated feed is potentially capable of dissolving 0.154 grain of iron, equivalent to more than 1½ grains per gallon.

"The word potentially is used advisedly. The solvent action is possible in full, given a clean and sufficiently extended metallic surface, and time; it is a function of time and surface. That complete saturation is ever approximated in practice is problematical, otherwise about 2-3 of a pound of iron would be consumed for 1,000 horse power hours.

"Known facts relating to feed pipes, economiser tubes, and those parts of boilers near the inlet, amply prove that marked oxidation may ensue when the gases are released by temperature increment, and whilst they still continue in a constricted fluid flow, in contact with relatively large bounding surfaces. Later, owing to the extreme tenuity of the gases when expelled into, and diffused through the steam spaces, and swept forward by the vapor, the bulk of the atoms never reach a corrodible surface."

When the corrosive action of the oxygen in the water is considered it will be seen that chemically pure water may not be the most desirable feed for a steam boiler. The presence of substances having an affinity for oxygen may prevent injurious action to the metal, but this depends upon the nature of the combinations. Thus, feed waters containing mineral matter might fix a portion of the free oxygen, and if the resulting salts are insoluble they will be deposited as mud or scale, and although objectionable for some reasons, will not corrode the iron. If the salts are soluble and corrosive, however, the oxidising agent will no longer be steam swept from the system, but remain to act upon the metal with which it comes in contact.

The action of the contained oxygen upon oil which may be in the steam is a matter of interest, and Mr. Smith notes some features in this connection.

"Oil in the atomised state presents, in relation to its mass, a very large superficies, but by reason of the gaseous diffusion, extreme effects need not be expected, unless

the action continues and is cumulative. Something of this nature may arise when feed containing emulsified oil circulates continuously through a surface-condensing plant.

"Holde's determinations of the absorptive power of mineral cylinder oils varies from 0.1 to 0.45 cc. per gramme—the figures are greatly higher for animal and vegetable oils, or mixtures of these with mineral lubricants—therefore free oxygen in the quantities found in practice may play a not inconsiderable part in the economy of steam lubrication. Possibly the difficulty of separating the emulsified oil from hot-well waters may be traced, in part, to isolation of particles consequent upon surface induration arising from the preceding cause."

The question may arise as to the action of oxygen contained in the steam upon the surfaces of a superheater, and here an interesting fact appears. The well-known Bower-Barff process for protecting iron from corrosion by the formation of a surface coating of magnetic oxide, involves the exposure of the heated metal to a current of superheated steam, the result being the formation of the highest oxide of iron which can be produced, and hence these surfaces are protected against further corrosion. At the same time there may be a corrosion, due to the action of fatty acids, produced in consequence of the oil-oxygen combinations. It is a matter of record that before the days of mineral cylinder oils, when tallow was extensively used as a cylinder lubricant, the metal of the valve-chests and cylinders of steam engines was rapidly corroded, doubtless by the production of fatty acids produced in the course of the oxidization of the animal oils.

Mr. Smith's paper gives a tabulated résumé of his own experiments, together with a temperature-gas-emission curve, and it will undoubtedly be found a valuable contribution of a feature in steam engineering which has hitherto been given insufficient attention.

## LIQUID FUEL FOR MARINE SERVICE.

TESTS CONDUCTED BY THE LIQUID-FUEL BOARD UNDER THE DIRECTION OF THE BUREAU OF STEAM ENGINEERING OF THE UNITED STATES NAVY.

*Journal of the American Society of Naval Engineers.*

WE have referred already in these columns to the important trials being conducted under the direction of the Bureau of Steam Engineering of the United States Navy upon the practicability of using liquid fuel for naval vessels, and the appearance of the complete report forms a fitting climax to the career of Rear Admiral Melville as Engineer-in-Chief of the navy, and Chief of the Bureau of Steam Engineering. Although the report has appeared since the accession of his successor, it represents work done during the incumbency of Admiral Melville, and the portly volume forms a most valuable contribution to the science of steam engineering. It is to be hoped that the rumors of the abandonment of the policy of publicity in the engineering work of the Bureau hereafter are unfounded, and we trust that Rear Admiral Rae will endeavor to make his Bureau of the same value to the engineering profession as his honored predecessor has done.

The report, which has been made by Commander J. R. Edwards, Lieut.-Com. W. M. Parks, and Lieut.-Com. F. H. Bailey, all of the United States Navy, is most exhaustive in its character, and is published in extensive abstract in the *Journal of the American Society of Naval Engineers,* and we give here some account of the work and the general conclusions which have been drawn.

The report is based upon a number of practical trials, the most complete of these being made by the Board itself upon a water-tube boiler arranged in the Washington navy yard in a manner reproducing as closely as possible the conditions obtaining on shipboard. To these have been added reports of the practical experience upon vessels, notably the voyage of the *Mariposa,* between San Francisco and Tahiti; the *Alameda,* between San Francisco and Honolulu, and the *Nebraskan* and the *Nevadan,* between New York and San Diego, California.

In the report are included detailed accounts of the construction and operation of the various forms of burners used, and a mass of practical experience acquired in the course of the trials.

Within the space here available but an abstract of the conclusions can be given, but the full report should be studied by every one interested in the use of liquid fuel for the generation of steam, whether afloat or ashore.

In the first place, there is no difficulty in burning oil in a uniform manner, and the necessary skill can be readily acquired by the labor available. The spraying of the oil may be very conveniently effected by steam, and for stationary plants this will probably be found the best method. On shipboard, however, the consumption of steam for spraying makes increased demands upon the evaporating plant for the supply of fresh water to the boilers, and hence compressed air is to be preferred. When the combustion is to be forced, as must undoubtedly be required on warships in emergencies, the best spraying medium is highly-heated compressed air.

The presence of water in the oil interferes materially with satisfactory combustion, and special provision should be made for the removal of the gradual accumulation of water in the bottom of the supply tanks. So far as evaporation is concerned, there is practically no difference between crude and refined oil, from 3 to 3½ barrels of oil being equivalent to a long ton of ordinary coal, while 4½ barrels of oil are required to evaporate as much water as a long ton of best Cardiff or Pocahontas coal. In addition to the advantages derived from the heating of the air it is advisable to have the oil heated, this aiding in securing uniformity of flow, while careful provision should be made for straining the oil to prevent the choking or clogging of the burners.

While it is doubtless desirable that installations for oil fuel should be designed for use with liquid firing, it is not difficult to apply the system to existing plants. The simplest furnaces show the greatest efficiency, and there is no necessity for filling up the combustion space by the construction of brick arches. In Scotch boilers there should be a simple vertical brick lining of the back combustion-chamber wall, and a lining of the front end of the furnace for about a third of its length.

Experience has shown that when oil is used as fuel in Scotch boilers the introduction of retarders in the tubes will prove beneficial, not only by preventing the products of combustion from passing too freely through the tubes, but also because of the more uniform distribution of the gases through all the tubes. Where oil is properly burned it can be regarded as a fact that the velocity of the flow of the gases is greater than where coal is used, on account of the retarding action of the soot formed in the tubes with coal firing. Retarders should therefore be used in the case of fire-tube boilers, and increased baffling in the case of water-tube boilers.

The efficiency of oil plants will be primarily dependent upon the character of the installation of fittings and auxiliaries. The form of the burner, so long as it is manufactured in accordance with certain well-known principles, and all its parts are accessible for overhauling, will play a very small part in extending the use of crude petroleum. The method and character of the installation is all-important, and therefore the work of designing and constructing such a plant should only be intrusted to those who have given careful study to the matter, and who have had extended practical experience in burning the crude product. Consumers should take especial care that they neither purchase appliances that have been untried, nor permit the installation to be effected by persons who have had but limited experience in such work.

Where crude petroleum has undergone a slight refining or distillation no ill-effects result to modern steel boilers. From the standpoint of endurance of the boiler, however, the advantage, if any, is with oil. Crude oil, however, by reason of its searching and corrosive effects, has a greater tendency than refined oil to attack the seams and tubes of modern boilers. For marine work, therefore, no crude petroleum should be used, and particularly for ships making long voyages the fuel oil should undergo some mild distillation before being placed in the tanks.

The report emphasizes the point that no

attempt should be made to use oil as auxiliary or supplementary to coal. Such an installation is certain to prove unsatisfactory, and the solution of the oil-fuel problem for naval purposes is only delayed by any attempt to inject a limited supply of oil fuel over a bed of incandescent coal. The mechanical features of the problem having been satisfactorily met, the good of the service requires that any installation attempted should depend upon oil as fuel alone and not in any combination with coal.

The most important portion of the report, however, after the entire practicability of the mechanical details of burning liquid fuel have been demonstrated, lies in the recommendations with regard to the supply. It is shown that the available supply of the world's supply of crude petroleum would not meet over 3 per cent. of the world's demand for coal and other combustibles, and hence efforts should be made to use oil fuel for special purposes only, and in particular localities.

In view of the fact that 48 per cent. of the world's output of crude petroleum is produced in the United States, and that practically the entire yield is secured from fields which are in pipe-line communication with important and strategic ports, the Board considers that a joint commission representing commercial, manufacturing, maritime, and naval interests should be authorized by Congress, whose province it would be to formulate such rules and regulations as would provide for an economical, efficient, enduring, and safe oil-fuel installation. Heretofore the oil-fuel problem has been principally investigated by various individual interests which have sought to secure information along certain lines and as a result there has not been secured that knowledge of the subject which would insure for the country at large such development of the use of crude oil for fuel as would be warranted, considering the natural advantages possessed by the United States in having at its command near great seaports so large a proportion of the world's production of the crude product. Particularly for the development of American commercial interests in the Gulf of Mexico and on the Pacific coast would the work of such a commission have an important influence in extending its prestige and power, whether viewed from a commercial, maritime, or naval standpoint.

## RESPIRATION DEVICES FOR MINES.

THE ARTIFICIAL REGENERATION OF AIR FOR RESPIRATION IN LIFE-SAVING APPARATUS FOR MINING SERVICE.

*Director G. A. Meyer—Glückauf.*

A VARIETY of devices have been made for protecting miners and others from the suffocating effects of gas and smoke, and thus enabling rescue parties to work in an atmosphere unfit for ordinary respiration. The earliest of these employed such methods as the use of moistened filters and the like, through which the air might be drawn, and these were followed by the provision of reservoirs containing air, usually compressed to enable sufficient to be provided, the supply being conveyed to the mouth and nose of the wearer by suitable connections of elastic tubing. More recently such appliances have been greatly improved by the substitution of small reservoirs of compressed oxygen for the air supply, this greatly extending the range of time during which the apparatus can be used, and other improvements have been made in the light of experience.

A very complete series of investigations have been upon such appliances in connection with the work of the Shamrock mine, in the Dortmund mining district in Germany, and from a report of these experiments, by Mining Director G. A. Meyer, in a recent issue of *Glückauf*, we make some abstracts.

The later respiration devices, such as that known as the pneumatophor, include the idea of a continual renewal of the air used by the wearer of the apparatus, the carbonic acid emitted from the lungs being removed by some absorbing substance, while the oxygen required for the blood is replaced by a supply of the compressed gas carried in a separate vessel. The original volume

of air is carried in a sort of bag, or knapsack, and by the continual removal of the carbonic acid and the replacement of the oxygen, it is maintained in a normal condition for breathing.

While these ideas are readily seen to be entirely applicable, there are numerous details of construction and proportion which have been found to require study and experiment, and the importance of insuring the continuous and satisfactory working of the apparatus is appreciated when it is remembered that both the life of the wearer and the success of the rescue work in which he may be engaged may be imperilled by any interruption or failure of operation. For these reasons the investigations carried out in Germany are of much importance and value, apart from the general interest which they possess from a technical viewpoint.

It is desirable that any such apparatus shall be wholly automatic, requiring no attention or regulation on the part of the wearer, since he naturally requires the greatest freedom of thought and action for the work in which he is engaged, and great care must be taken that he shall be free from any irritation or inconvenience from the apparatus which he is carrying.

The absorption of the carbonic acid is effected by various materials. In the older devices a solution of soda-lime was employed, but there are objections to this, both on account of the imperfect absorption of the carbonic acid, and also because any liquid is inconvenient for transport, and because even a small amount carried in suspension in the air acts to irritate the mucous membrane of the organs of respiration.

The improved methods employ a dry absorbent, preferably caustic potash, but care must be taken in its employment, since the moisture in the exhaled breath acts to form a solution which, re-evaporated, may be inhaled and produce severe irritation. The extent of this difficulty will appear when it is stated that the watery accumulation of two hours amounts to about 120 cubic centimetres, forming a strongly caustic liquid. The remedy for this difficulty is found in the provision of some convenient substance for the absorption of the moisture, such as charcoal, or kieselguhr, or infusorial earth, such methods being found wholly effective.

The replenishing of the oxygen of the air is controlled by a reducing valve, which can be so adjusted as to permit a flow from the high-pressure reservoir at such a rate as to correspond to the consumption by the wearer of the apparatus. Some interesting experiments have been made in this connection, a résumé being given in Director Meyer's report, to determine the proper amount of oxygen to be supplied. These experiments, conducted by Dr. Leo Zuntz, of Berlin, upon bicycle riders, show that a rider, while standing, required 263 cubic centimetres of oxygen. The same individual, while operating his bicycle at the rate of about 21 kilometres per hour, required 2,351 cubic centimetres of oxygen, or nearly 9 times as much as before, the increased demand being the result of the muscular exertion. Experiments at lower speeds showed the reduction in the demand with the reduced effort; thus, a speed of 15 kilometres was accompanied with a consumption of 1,442 cubic centimetres per minute, while for a speed of about 9 kilometres the demand fell to 932 cubic centimetres. Comparing these with earlier investigations, as well as with some more recently made, it appears that the consumption varies for different individuals, and that the high rates correspond to brief periods of unusual exertion, not to be continuously maintained. An average consumption may be taken at 1 litre, or 1,000 cc., and the Walcher pneumatophor provides 2 litres per minute as an amount which may be supplied on demand.

Various details of arrangement of apparatus are shown in the report of Director Meyer, these being mainly directed toward the arrangement of the parts to insure strength and convenience. The air reservoir is usually made in the form of a flat bag, to be strapped to the shoulders, and it should combine the qualities of lightness with great toughness and strength, since any rent or tear would be fatal. The oxygen is contained in one or more metal flasks, with a volume of about 2 litres, the oxygen being compressed to 120 atmospheres, and thus furnishing a supply for about two hours. Usually three oxygen flasks are provided, each with its own valve, so that one may be used after another, this enabling the reduction of pressure to the regulated, besides providing against a loss of the en-

tire charge should a leak in any one flask occur. The oxygen is supplied to the air automatically through a reducing valve, a variety of injector delivering a fine jet of the gas into the current of air which is to be regenerated. A special form of mouthpiece fits over the face of the wearer, including tubes for the nostrils, and the various designs shown indicate the care which has been taken to present the minimum of inconvenience to the wearer.

In addition to the provision for the regeneration of the air used by the wearer, the apparatus includes a connection permitting the use of a portion of the oxygen for the resuscitation of individuals who may be reached in the course of the rescue work, a feature of the utmost value.

The report is fully illustrated, and contains interesting information concerning experimental trials which have been made with various forms of apparatus, and the whole forms the latest and fullest contribution to this important department of mining work.

## PROBLEMS OF ENGINEERING EDUCATION.

### THE OUTLOOK FOR TECHNICALLY EDUCATED MEN IN FIELDS OF PRACTICAL ENGINEERING WORK AND APPLIED SCIENCE.

*C. Frank Allen—Society for the Promotion of Engineering Education.*

ONE of the elements in technical education in the United States commented on most freely by visitors from other countries has been the promptness with which the graduates from technical colleges are received into practical work. In England even yet the old-time practice of requiring a premium in money as a condition of admittance into an engineering works or office holds good, and some time in addition must elapse before the applicant can expect to receive a living wage, while in the United States the experience of many professors in the more important educational institutions is that the best members of his graduating classes are offered paying positions before they have received their degrees.

In the presidential address of Professor C. Frank Allen, before the meeting of the Society for the Promotion of Engineering Education at St. Louis, this matter is discussed at length, the various openings for technical graduates being examined in turn.

"Employment in engineering has generally but not always proved the goal for the graduate. In many cases it has rather been the channel, the period of preparation or probation for duties of a somewhat different character. In an increasing degree it has been found advantageous and desirable to secure superintendents, managers, presidents of railroads and other semi-engineering enterprises by promotions from among the school-trained engineers. The policy of that splendid railroad system, the Pennsylvania, has long since been established; the civil engineer engaged upon maintenance of ways finds himself directly in line of the office of Division Superintendent, to whom in turn the office of General Manager or even of President is in line and an evident possibility. A large number of mechanical engineering graduates are now entering upon railroad work; indeed, in many instances in the past they have been selected to occupy the highest operating positions; there seems no reason why the prizes in future should not be fairly or evenly divided between the mechanical engineers, while the rapidly increasing importance of electrical propulsion, and of electricity in signal work and otherwise will shortly demand a knowledge of electricity which will give to the electrical engineer an importance in general railroad work sufficient to introduce a new element of competition which the civil and mechanical graduates must face."

Professor Allen includes in the openings for technical graduates the field of contract work, and in this much discussed department of industry his views are of interest as being distinctly broader than is sometimes the case.

To some this has seemed, in civil engineering at least, as a lowering of dignity. A somewhat broader view appears to be that methods of executing wok are often more important as features of engineering than is the ultimate design. Furthermore, if the school-trained engineer-contractor

does bring to his work greater skill in execution, greater pride in honesty of construction, and a better analytical understanding of the cost of various elements of the work, with diminution of the risk, and a consquent lowering of the cost (as I believe he does) then the contractor is not and ought not to be, as sometimes in the past, in any sense a constitutional foe of the engineer in charge, but rather a help, or better, an engineer legitimately in the practice of a special branch of engineering which ought properly to attract those whose abilities and tastes lead them towards it. In bridge work, machine shops, electrical manufacturing and installation, and many kinds of engineering it has long been true that the standing of the contractor has been inferior on the whole to no other class of engineers."

One of the most interesting features of the subject, as brought out by Professor Allen, appears in the extent to which men with engineering training are found in demand for other departments of work. Formerly the engineer was supposed to be a specialist, and the general collegiate education was assumed to be the real thing to equip a man for the more general duties of life. It is becoming evident, however, that a training in methematics and science is such as to bring out the best qualities in a man to as full an extent as can be done by a study of the classics and philosophy.

"The field chosen by the individual for his opportunity is not always pure engineering. While the demand for engineering and the demand from engineering enterprises, the demand for engineering graduates, the demand for engineering education is strongly on the increase, yet the day of trouble is before us, the day of financial crisis, when enterprises languish, when the demand falls sharply off, and the supply continues, although in diminished numbers. Then will come the time when the practicing engineer and the engineering graduate will find a necessity, not now existing largely, to make for himself his opportunity which will lie outside the established lines of engineering; when he must accept not what he would but what may be offered, and the engineering graduate will be forced into general business, into manufacturing. It seems reasonable that his greatest usefulness will first be found with dealers in engineering or mechanical supplies, or in manufacturing where engineering skill can never be amiss; already the demand in these directions has become a reality, rather than a possibility. Already some of the manufacturers' insurance companies employ a large force of men trained in engineering. Life, fire and marine insurance constitute, likewise, reasonable fields. Banking, and the sale of stocks and bonds, are occupations to which in many instances engineering graduates have already found themselves adapted by the training they have received and in which the line of study followed in the engineering college has been found frequently to be of practical advantage."

It has been maintained by some that the training imparted in an engineering course impairs the development of the executive ability, but there appears to be no good reason why this should be the case. There is no doubt that many men now holding executive positions of importance have come from the class of technically educated students, and evidence on the other side appears to be wholly lacking.

An important element in engineering education appears in the manner in which honest and sincere methods of thought are inculcated. A man may deceive others, or even himself, by sophistical arguments, so long as the matter goes no further, but when his deductions are obliged to be incorporated into iron, steel, stone, or concrete, or when his theories are compelled to be put into active motion and intrusted with the responsibility of lives and fortunes, he realizes that the defects will make themselves known, despite any argument or verbal juggling. An engineer must be an honest man, so long as he deals with the laws of Nature, laws which have an inconvenient habit of enforcing themselves, without possibility of deception or persuasion. Herein appears the moral side of an engineering education, which, as Professor Allen says, is a natural result of an intimate acquaintance with scientific methods and reasoning.

"The study of science is, it must be, the search for truth, and it must from usage cultivate a love for truth. That the scientific attitude of mind is of supreme importance as an element of character building seems to me in principle to admit of no doubt. As

a matter of observation, I know of no class of men whom I believe to be less subject to business corruption than the civil engineers who have come more especially under my notice, and I do not doubt that the school-trained mechanical, electrical and mining engineers are men of equally high character.

"The influence of a training in methematics and science is also calculated, it seems to me, to develop another important element of character. The student learns in mathematics that correct procedure will secure correct results; in science correct observation and proper reasoning again will secure correct results. A clear appreciation of these truths naturally leads to the establishment of that quality of character which we call courage. An engineer unless he is trained so as to have acquired something of courage is comparatively valueless. A very able editor in the engineering field once stated that an important value of engineering education is that it enables one to look a fact in the face. It sometimes takes courage to do that. To me it seems most important that any business man should have learned courageously to look facts in the face; if the facts show not only present but also future losses as the result of continuance of a given policy or even of a given enterprise, the sooner the truth is known the better. Not all business men are proof against self-deception."

Professor Allen certainly appears to have made out a good case for the standing of the technically-trained man in the community, and we have only to look about us to see for ourselves the extent to which his views are confirmed by experience.

## THE DEVELOPMENT OF THE FORGING PRESS.

APPLICATIONS OF HYDRAULIC PRESSURE FOR THE FORGING OF IRON AND STEEL IN PLACE OF THE STEAM HAMMER.

*Baumeister Peter—Glasers Annalen.*

THE persistence in the use of the hammer for the purpose of forging iron, is an excellent example of the manner in which mechanical practice has been diverted from the true logical line of development because of the influence of precedent. The hammer was undoubtedly the best tool for use by the human arm, therefore, when power came to be applied to the same work a bigger hammer was used, the details of the old-fashioned tilt hammer following the construction of the hand hammer as closely as the early railway carriages copied the lines of the stage coach. Even when Nasmyth broke the precedent by designing a steam hammer without a handle, he failed to realize that the true method of forging was by use of Bramah's hydraulic press, a machine which had already been perfected for other work and was ready to his hand. It was not until the magnitude of the work reached limits which made it apparent that the time element entered into the operation, and that a quick blow did not affect the interior of a mass to a sufficient extent, that engineers turned to the method of forging by pressure instead of impact.

In recent issues of *Glasers Annalen* the development of hydraulic forging machinery is discussed at length in an admirably illustrated article by Baumeister Peter, and from this we make some abstracts, reviewing the salient points.

The use of pressure in iron working appears in other departments than forging at an early date. The operations of rolling are also processes of working by pressure, but the first use of direct pressure appears in the employment of the "squeezer" for the expulsion of the slag from the puddled metal. Various forms of squeezers were used, the earlier types being of the alligator model, again following precedent and using what was really an enormous pair of pincers, operated by a cam movement, for compressing the ball of hot metal between its jaws. Later the rotary squeezer was designed, the metal being rolled through a gradually diminishing space between a fixed housing and an eccentrically placed roll. The hammer maintained its supremacy for forging, however, until it became evident that external pounding of large ı asses acted only to condense the exterior portion, leaving the interior nearly in its original open and porous condition.

The development of hydraulic forging and other forming operations by hydraulic pressure was greatly advanced by the introduction of the hydraulic accumulator. This avoided the necessity of using a pump capacity otherwise required for the maximum demand, besides equalizing the load and giving a smoother action to the ram of the press than by direct pumping.

Herr Peter illustrates the development of the forging press by showing the various forms successively, although the machines given are principally from German practice. The earlier presses of Haswell and of Whitworth are shown, followed by the improvements of Davy, Fielding and Platt, Krupp, Haniel and Lueg, and others, and the attention which has been given to detailed improvements is very clearly exhibited. Thus it was soon found that a marked economy in water was effected by using small auxiliary cylinders for raising the ram after a pressure stroke had been made, this arrangement also enabling a quicker return stroke to be made. Various arrangements of cylinders have been adopted by different builders, but in general the forging press consists of a massive upper and lower yoke, connected by strong columns, one yoke carrying the cylinder, with its ram and the other supporting the anvil, as it may be termed, the pressure being opposed by the rods which tie the two yokes together. Some presses have more than one ram, and the minor details are modified to suit the nature of the work.

Modern accumulators permit the use of working pressures ranging from 2,500 to 10,000 pounds per square inch, the total effort exerted by the ram reaching, in the case of the great press at the Krupp works, as high as 5,000 tons; while the press at the Bethlehem Steel Works exerts a total pressure of 14,000 tons.

Herr Peter reviews the auxiliary arrangement for use in the working of hydraulic forging presses, including the furnaces for heating the metal, the various handling devices, cranes, hoists, etc., giving an excellent idea of modern practice. He also gives a number of examples of the manner of working large shafts, armor plates, and other pieces of forge work, with illustrations.

In addition to the use of hydraulic power for forging, it is coming into use for shearing heavy masses, such as armor plates, and also for operating forming presses for shaping heavy boiler plate for boiler heads, and for special shapes. The bending press is also found valuable for curving the heavy plates required for the shells of marine boilers of the Scotch type, and for shaping armor plates for special positions, such as the protection of turrets, babettes, and conning towers of battleships.

The paper of Herr Peter is a satisfactory contribution to a department of modern shop practice concerning which but little has been published, and such articles are to be welcomed as useful additions to technical literature.

## THE FIRE RESISTANCE OF MODERN HIGH BUILDINGS.

EFFICACY OF MODERN METHODS OF FIREPROOFING WHEN INTELLIGENTLY AND HONESTLY EXECUTED.

*Perez M. Stewart—International Association of Fire Engineers.*

At the recent meeting of the International Association of Fire Engineers at Chattanooga a paper was presented by Mr. Perez M. Stewart, reviewing at length the lessons of the year in regard to the effectiveness, or otherwise, of modern systems of fireproofing, with especial reference to the protection of modern high buildings; a subject of such vital importance to the community, and so closely allied to the work of the engineer in many directions, as to demand notice and review.

During the past twelve months several exceedingly large fires have occurred, and these disasters have fully sustained the theory and practice of modern fireproofing methods.

"A more complete vindication of the contentions of fire protection engineers generally could not have been had than was given in the great fires at Baltimore, Rochester and Toronto. Each type of material, each method of building practice failed or succeeded in accordance with the knowl-

edge and belief of all who had made, previously, a study of the subject. There were no surprises, only vindication—vindication of the prophecies of disaster made last year, made now and to be made in all the years to come, so long as improper materials and bad engineering practice enter into the composition of our buildings. Too much emphasis cannot be laid upon the vital need of high standards of specification and of living up to them in matters pertaining to fire protection, for, as a famous underwriter has said: 'Fire protection is peculiar in that to be efficient it must be complete. No compromise is possible, since ninety-five per cent. of efficient construction may be vitiated by five per cent. of omission, oversight or misjudgment.

"The force of this is obvious when it is considered how intimate are the relations among the fire resisting properties of the different members of a building; how the failure of one member may throw an added burden on another and at the same time deprive that other member of the power to sustain its original burden."

It is in this respect especially that questions relating to fireproofing demand the attention of the construction engineer to a greater degree than is sometimes found. The loads, wind stresses, shocks, and other elements are all carefully computed in determining the proportions of the various members, without considering that in many instances more mass is required to resist fire than to meet all the other stresses taken together. The first requisite in the design of a fireproof building, then, is an appreciation by the engineer that stiffness and solidity of construction must be provided, and that a flimsy built structure, with just a little more strength than is required to resist the mere statical loads, is not a proper framework for any system of fireproofing.

Good designing, however, is of little avail unless it is followed by honest workmanship, and unfortunately this is not always the case.

"The standard of workmanship in buildings is very low—often criminally so. The factor of safety provided in the design against other contingencies is often drawn upon to the limit of failure as tribute to dishonesty and carelessness. Owners need to learn the value and the necessity of adequate inspection, and it does seem that some architects should enlarge their ideas of what is meant by the word 'supervision.'

"Finally, it may be said that much of the damage at Baltimore was due to poor workmanship as well as to flimsy design. Many terra-cotta partitions and column coverings were so loosely laid up that they were entitled to fall down without any other excuse at all. There were cubic yards of bricks in the walls of the Continental Trust Building which were simply thrown in loose without any pretense of laying. It should be remembered that good workmanship may save a defective design, but no excellence of design can adequately provide against dishonest work.

"Again and again cases are met with where effective fireproofing was specified for buildings by the architect or engineer, for which, in the construction, an inferior method was substituted by the contractor, supported by the owner, simply because it was cheaper, resulting, seemingly, in a saving to the owner, and undoubtedly in an increased profit to the contractor."

One of the difficulties encountered in advocating proper design and honest execution of the work is found in the attitude of the owner. This difficulty has been well stated by Mr. Edward Atkinson in words which will well bear repeating.

"The mental attitude of the average owner and occupant toward the underwriter becomes of prime importance; as a rule, it is antagonistic. The owner is apt to think that his only duty is to secure an efficient fire department, an excessive public water supply, and to take out a policy of insurance on his property. This policy he seldom reads and often could not comprehend it if he did. He trusts to an insurance broker or agent to make the contracts on the best terms, being eager for a low rate, whether adequate or not to keep the insurance companies solvent. He may put in private apparatus and may hang up cheap hose only to satisfy the inspectors of the insurance company, whom he looks upon as inquisitive persons to be tolerated, but gotten rid of with the least trouble. He rarely, if ever, seeks to know what avoidable causes of hazard the inspector may have found, and he grumbles when the rate of premium is

put up. He often tries to prove a larger loss than has occurred and to get as much as he can out of the adjusters when fire has damaged his property. He seldom comprehends and utterly neglects his own responsibility for the construction and protection of his own property.

"The complete removal of such hazards will only be attained when occupants as well as owners can be brought into a psychological condition or mental attitude in which they will welcome the underwriters and their inspectors as their next friends, instead of resenting their inspections and regarding them as a necessary evil to be tolerated, but to be ignored as much as possible."

Coming to the actual methods of protection, and assuming as absolutely essential a strong and massive steel skeleton, upon which to place the protection, the results of recent experience show that nothing is better than a high grade of Portland cement concrete. This has shown itself superior to hollow tile, to plaster of Paris blocks, or to plaster on metal lath. The best material, however, is ineffective if the protection is too thin, or is not properly secured.

Mr. Stewart gives a number of examples of recent fire-proof construction, showing that proper protection is altogether possible by the adoption of proper engineering methods in design, followed by sincere and honest construction, with owner and builder in accord as to the fundamental importance of adhering strictly to the accepted principles of scientific fireproofing.

To put the matter briefly, the several fire hazards and means for their reduction may be summed up in general as follows:

Iron and steel structural building members lose their strength rapidly under the influence of even moderate heat, therefore should be thoroughly insulated. Portland cement concrete and hollow tile, not less than two inches in thickness at any point, are most efficient against the attack of both fire and water.

Vertical openings throughout buildings, as for stairs and elevators, rapidly communicate fire between stories. With buildings of considerable height or combustible contents this is likely to result in fire conditions beyond fire department control. All such floor openings should be enclosed in brick walled shafts, crowned by a thin glass skylight and extending through roof and with fire doors at openings to stories. All vertical light openings in such shafts should be glazed with wire glass.

Large, unbroken floor areas assist the spread of fire and serve to augment its severity. Buildings of considerable area and having large quantities of combustible contents should be sub-divided by substantial brick fire walls sufficient to form a positive barrier to the spread of fire.

Stair treads should preferably be of iron or its equivalent. If slate or marble treads are used they should be supported by a metal plate beneath.

A large portion of fuel for combustion, in buildings having brick walls, is supplied by the trim, floors, etc., as well as by such furnishings as are necessary for occupancy. Much of this can be avoided by the use of substitutes for wood, or of metal-clad covered wood and metal covered furniture.

Nearly one-third of the total fire loss is caused by the contribution of flame from one building to another through window openings. All windows subject to exposure should be thoroughly protected against the attack of heat. Wire glass in non-combustible frames has proven most efficient for the purpose, as it is always in position and is not subject to deterioration.

Every aid to the fireman, in the shape of fixed equipment in the building, adds so much to his capacity. Fire alarms and thermostats, standpipes, stationary nozzle and sprinklers all mean more prompt and efficient application of water, and should be most generously and generally encouraged.

Last and most important, and this applies to the whole range of fire loss reduction, only such systems and devices as have demonstrated their efficiency should be specified, and only such workmanship as lives up to the most rigid specifications should be permitted.

It is not to be expected that reform can be instituted very rapidly. Prejudice—especially that form against things not wholly understood—must be overcome, municipalities must be goaded into action, and every aid invoked if we would hasten the time when all but the most extraordinary fires can be confined to the floor, or at least to the single building in which they originate.

# ELECTRIC TRACTION FOR RAILWAYS.

FEATURES IN THE HISTORY AND DEVELOPMENT OF ELECTRIC POWER AS APPLIED TO RAILWAY TRACTION.

*International Electrical Congress.*

WHILE the applications of electric power have appeared in many useful ways there is probably no direction which has been made more apparent to the general observer than the substitution of electric for animal power on street and local railways. The development of electric traction for interurban service is an extension of local tramways, and numerous predictions have been made as to the ultimate replacement of steam by electricity for main-line service.

Such an important department of applied electricity naturally received attention at the International Electrical Congress at St. Louis, and among the important papers presented we note a valuable contribution to the history of the subject, by Frank J. Sprague, an account of his pioneer work in single-phase electric traction, by Bion J. Arnold, together with papers by Charles Proteus Steinmetz, R. A. Parke, Professor Dr. Niethammer and Lewis B. Stillwell.

Mr. Sprague reviews the early history of electric traction, noting the pioneer experiments of Davenport, in 1834, followed by the work of Jacobi, Farmer, Page, and others, before the introduction of the dynamo, after which the experiments of Siemens & Halske, Felix and Chretien, Deprez, and others, directed the attention of engineers to the possibilities of the application of electric power to traction purposes.

After the dynamo was more fully developed, and the possibilities of the electric motor began to be appreciated, numerous engineers were attracted to the subject of electric traction, the most active experimenters being Field, Reckenzaum, Van Depoele, Daft, and Sprague himself.

"Reviewing the conditions at the beginning of 1887, statistics compiled by Mr. T. Commerford Martin show that, including every kind of equipment, even those a fraction of a mile long and operated in mines, there were but nine installations in Europe, aggregating about 20 miles of track, with a total equipment of 52 motors and motor cars, none operated with the present overhead line or conduit, and seven cars operated by storage batteries, while in the United States there were only 10 installations, with an aggregate of less than 40 miles of track and 50 motors and motor cars, operated mostly from overhead lines with traveling trolleys flexibly connected to the cars. These were part Daft, but principally Van Depoele roads. Almost every inventor who had taken part in active work was still alive. The roads, however, were limited in character, varied in equipment and presented nothing sufficient to overcome the prejudices of those interested in transportation, and command the confidence of capital. The whole electric railway art may fairly be termed, and was in fact for sometime afterward, in an experimental condition, and some radical step was necessary to overcome the inertia which existed, and inaugurate that development which has been so remarkable.

"This came in the spring of 1887, when the Sprague Electric Railway and Motor Company took contracts for roads at St. Joseph, Mo., and Richmond, Va., the latter covering a road not then built, and including a complete generating station, erection of overhead lines, and the equipment of 40 cars each with two 7½-hp. motors, on plans largely new and untried. The price, terms, and guarantees were such as to impose upon the company extreme hazards, both electrical and financial. The history of the Richmond road has been too often written to dwell upon it at any length here. Suffice it to say that after experimental runs in the latter part of 1887, it was put into commercial operation in the beginning of February, 1888, and for a year there followed an experimental period of development which taxed the technical and financial resources of the company to the limit. But it won out, and Richmond, by common consent of history, now stands as that pioneer road which more than any other was effective in the creation of the electric railway as it stands to-day."

After the success at Richmond had dem-

onstrated the practicability of electric traction for street railway service, various improvements were made, but the next awakening demonstration, largely by reason of the public nature of the situation, was the Intramural railway at the World's Fair at Chicago in 1893. This was soon followed by the application of electric traction to a portion of the elevated system in Chicago, and by the general replacement of cable traction in cities by electric traction, the overhead trolley system being very generally used.

The paper of Mr. Bion J. Arnold gives some interesting information concerning the replacement of the 500-volt continuous-current system for electric traction, by alternating currents at higher voltages, including the employment of transformers and converters at sub-stations. The account which he gives of the plans for the Inland Lakes Road, a line designed in 1896, but never executed in its entirety, is most valuable, as showing the difficulties opposed to a system now in general and most successful service. The important portion of Mr. Arnold's paper, however, lies in the detailed account which he gives of his system for the direct use of the single-phase alternating-current motor for traction. This system is in reality a combination of electric and pneumatic traction, the power being derived from a constant-speed single-phase alternating-current motor with reversible air compressors and engines, the pneumatic portion of the machinery absorbing and giving out energy as required, and permitting the electric motor to be run at a constant speed. This arrangement gives the alternating system the flexibility otherwise lacking, and permits the direct use of alternating currents for traction without involving the use of two or more contacts as demanded by polyphase systems.

Dr. Niethammer discusses the development of electric traction in Europe, comparing alternating and direct-current systems, illustrating many important installations, including the polyphase systems of Switzerland and of northern Italy. His summary of the situation in Europe is interesting, especially in the light of what is being done in the United States.

"Years ago direct current was declared entirely unsuitable for long lines and heavy traffic; to-day many give up three-phase and direct current to use only single-phase, of which we know very little as yet, from a practical standpoint. I believe that all three systems may counterbalance each other; yet each of them lacks some desirable features. Direct current is restricted to low train voltages and needs expensive sub-stations; three-phase railways make two trolley wires necessary, are very sensitive to voltage variations and badly overload the central stations; the last two disadvantages are more or less applicable also to single-phase lines, which possess the additional troubles on the commutator and the low efficiency. None of the systems offers the possibility of running through parts of the line independently of an outside current source. Up to the present neither of the other systems is known to be as reliable and safe as the direct current. The first costs of the car equipments are throughout higher for three and single-phase than for direct current; for equal voltage the line equipment is cheapest for direct current; but the possibility of using high trolley voltages for alternate currents shifts the result essentially in favor of single and three-phase currents, mainly the former. The sub-stations are more expensive for direct current, while the central station costs least for direct current. As to the operating expenses, the cost of attendance for the sub-stations is unfavorable to direct current. The result of serious comparison between the systems shows usually a difference in first cost of not over 10 to 25 per cent. and the difference in operating expenses is even less and in many cases the results are in favor of direct current, between three-phase and single-phase there is no essential difference as to price, single-phase having the advantage of simplicity and the possibility of higher trolley voltage, but possesses the disadvantage of needing a commutator.

"For long lines and heavy trains with low accelerations, three-phase equipments will always have good chances, especially if through trains are arranged and all shunting is done by special engines. On urban and suburban lines, direct current is entirely sufficient and satisfactory, though a reliable single-phase motor will be a hard competitor, as single-phase equipments may be arranged to suit both long and short lines."

Some idea of the progress which has been made in the application of electricity to the purposes of traction will be gathered from a summary of statistics given by Mr. Sprague, together with an indication of what this new industry has accomplished for the welfare of mankind.

"To illustrate in a general way the growth of the electric railway it should be noted that three years after the inauguration of the Richmond road there were in operation or under contract in the United States, England, Germany, Italy and Japan, not less than 325 roads, representing an equipment of about 4,00 cars and 7,000 motors, with 2,600 miles of track, on which there was made a daily mileage of not less than 400,000 miles, and three-quarters of a billion of passengers were carried annually.

"By the end of 1903, in the United States alone, there was a total of over 29,000 miles equipped, 60,000 motors and 12,000 trail and service cars in service, and the passengers carried ran into billions.

## THE EFFICIENCY OF THE GAS TURBINE.

A THEORETICAL STUDY OF THE CONDITIONS OF ACTION BASED UPON DATA FROM PRACTICAL TRIALS.

*Alfred Barbezat—Schweizerische Bauzeitung.*

WITH the rapid and successful development of the steam turbine it has occurred to a number of engineers that a similar successor to the gas engine in the form of a gas turbine might readily be made. Some experimental work has been done, both in the United States and in Europe, but very little information has been made public, this indicating that the practical results have not been attended with that degree of success which would warrant any commercial undertakings. It now appears that Messrs. Armengaud and Lemale have been running an experimental turbine, driven by the direct products of the combustion of petroleum at constant pressure, and that this machine has been in operation for more than a year in the works of the *Société des Turbomoteurs* at Saint Denis, near Paris.

In a recent issue of the *Schweizerische Bauzeitung* this machine is described in a contribution by M. Alfred Barbezat, who proceeds to develop a theory of its action by means of which the efficiency for any given temperature range may be computed. The mathematical nature of the article is such that it cannot be reviewed at length, but must be studied in the original, although the results are expressed in graphical diagrams which are useful as means of applying the results. A section of the generator and machine is also given, showing the extreme simplicity of the apparatus, and its applicability as a motor.

It is not maintained that the gas turbine will give a higher thermal efficiency than the reciprocating gas engine, but it is believed that to all the great advantages of the gas engine will be added those of the steam turbine, including simplicity, continuity of action, lightness in proportion to the power developed, economy of space, together with freedom from the incumbrance of boiler and furnace. An important advantage especially is seen in the substitution for the intermittent action of the Beau de Rochas cycle, of a continuous tangential impulse upon the rim of the wheel, the gain in this respect being greater for the gas turbine over the gas engine than in the case of the steam turbine over the reciprocating steam engine.

In the Armengaud and Lemale apparatus the combustion takes place in a pear-shaped vessel, the air and petroleum being delivered under pressure at the large end, through a special form of burner.

The burner is of annular form, the liquid fuel being delivered in the middle and the air around it, while the gases and products of combustion are discharged from the other end, through a suitable diverging nozzle, directly against the double buckets of the wheel; this latter being similar in construction to a Pelton water wheel.

The combustion chamber is protected against overheating by a water jacket arranged in the form of a spiral passage formed in the thickness of its walls, the water thus becoming continually hotter and hotter as it proceeds, until it is finally dis-

charged in the form of vapor into the interior of the chamber through a series of small holes arranged around the entrance of the discharging nozzle. The intense heat at this point adds to the expansive force of this vapor of water, and thus all the heat which has been absorbed by the water jacket is delivered with the hot gases against the turbine wheel as energy. The air, liquid fuel, and circulating water are delivered by suitable pumps deriving their power from the turbine itself, so that the available power is the difference between that generated by the turbine and that absorbed by these pumps. It may be of interest to compare this generator with the constant-pressure generator of Mr. Warren, illustrated and described in our issue of February of the current vear, both devices using the vapor of the cooling water, mingled with the gases of combustion, for delivery to the motor. In the Armengaud and Lemale generator a temperature of 1,800° C. is maintained in the combustion chamber, the constant expansion of the gases and vapor of water causing a stream of high velocity to be discharged through the nozzle upon the buckets of the turbine wheel.

M. Barbezat takes the data derived from these experiments, and discusses them in accordance with the thermodynamic theory of gases, drawing curves corresponding to the energy evolved as well as that consumed by the air compressor, from which it appears that with a temperature of combustion of about 1,800° C. and a temperature of discharge of 920° C. in the gases delivered against the wheel, the efficiency of the apparatus will be about 18 per cent.

In this case the initial pressure is about 15 kilogrammes per square centimetre, or about 212 pounds per square inch, and this performance is not better than is already obtained with the reciprocating gas engine, and is decidedly lower than is given by the best petroleum motors, such as the Diesel. At the same time the advantages of the continuous rotary motion, together with the simplicity of the machine renders it important that thermal efficiency alone should not be made the criterion by which the machine is judged. It is also possible that higher pressures may be used to advantage, and that the temperature range can be increased, so that still better results may be attained. The fact that a practical gas turbine has been made and operated continuously is in itself a matter of technical interest worthy of note, and if the machine receives but a portion of the attention which has been given to the steam turbine or the reciprocating gas engine, it is probable that further improvements will be made.

## STEAM POWER-PLANT ENGINEERING.

DATA AND RESULTS OF ECONOMY TESTS OF A REARRANGED STEAM POWER PLANT IN A MANUFACTURING ESTABLISHMENT.

*E. G. Hiller—Institution of Mechanical Engineers.*

AT the present time, when the whole constitution of power-plant engineering is undergoing revision it is especially important to have reliable data available as to the performance of the various claimants to public favor. The steam engine of the older reciprocating type is finding its pre-eminence assailed by the turbine for large installations and by the internal-combustion engine for the smaller powers, while the distribution of electric power from central stations comes in as a factor to be considered by power consumers of all kinds. The mill owner naturally hesitates to make radical changes unless he is convinced that nothing better than he now has can be offered, and in many instances he believes that the best thing to be done at the present period of transformation is overhaul the old plant along modern conservative lines and await developments. It is in such a manner that the power plant of the Bessbrook Spinning Company has been rearranged, and an interesting account of the manner in which the work has been done, and the results accomplished, forms the subject of a paper recently presented before the Institution of Mechanical Engineers by Mr. Edward G. Hiller.

Mr. Hiller rightly maintains that the aim in the installation and operation of such a

plant should not simply be to obtain an engine which would use the smallest number of pounds of steam per indicated horse power per hour, but one which would, taking into account the capital, maintenance, fuel, water, and other incidental expenses, produce the power required on the flywheel at the lowest total cost for steam plant.

"The alterations at the Bessbrook Mills are an interesting example of the advantage of converting a group of old mills, driven by separate and independent steam engines, to a method of driving from a central station with more modern and economical plant.

"In the case of the Bessbrook Mills, the buildings formed three sides of a quadrangle, with one wing forming an extensive weaving shed, driven previously by a separate horizontal cross-compound tandem engine with horizontal air-pump. The other wing was driven by bevel gearing from the main block. The main block itself consisted of two mills placed end to end, with each portion driven by a separate engine. One of these engines was an old pair of beam engines, and the other engines a pair of double tandem compound horizontal engines. The three engines drove by gearing, there being altogether three upright shafts and three sets of horizontal second-motion shafts.

"The most suitable site for the new engine was on the side of the mill furthest from the present boiler house, and, consequently, an exceptionally long steam pipe range was necessary. Due account had to be taken of the high price of coal at Bessbrook (which may be taken approximately at 16s. per ton), the necessity for avoiding breakdowns, the isolated position of the mills in the country, and their distance from any large engineering centre, where, in the event of breakdown, skilled workmen could be readily obtained.

Without going into the details of the new engines and steam plant which are given very fully in the paper, it may suffice to state that it included a horizontal compound automatic condensing engine, with a cylinder ratio of about 4 to 1, Lancashire boilers, and a Musgrave and Dixon superheater, giving a superheat of about 60° F. The engine is fitted with a reheater between the high and low pressure cylinders, and the tests show the performance both with and without this being in action. An interesting feature of the engine appears in the regulating apparatus.

"The governing of the engine is effected by an ordinary high-speed centrifugal loaded governor, assisted by a supplementary governor. The load on the main governor partly consists of a weight secured to the end of a screwed lever. The sensitive supplementary governor at the slightest change from middle position can, by means of gearing, slowly screw this lever and its balance-ball outwards or inwards if the engine varies from the desired mean speed, and this action takes place quite independently of any quicker movement of the main governors. In this way, while the prompt action of the main governor is not affected, nor the length of the governor-rods altered, as in some arrangements, it is possible to secure an almost dead mean speed irrespective of permanent load changes, vacuum variations, or boiler-pressure fluctuations.

The performance of the engine is excellent, the steam consumption being 11.25 pounds per indicated horse-power hour, and the fuel required being 1.46 pounds of coal per horse-power, as fired.

An interesting feature of the tests was the experience with grease separators, and tests of a number of such appliances given in the paper show that with condensing engines exhausting into a high vacuum the velocity of the steam is such that the entrained oil is nearly all carried along with the exhaust steam into the condenser and thence to the boiler. This was true both for separators consisting of a plain chamber and those fitted with baffle plates or diaphragms of wire gauze, and Mr. Hiller is of opinion that the preferable method of removing the grease from the exhaust, under these conditions, is by the alumina-ferric, or other allied processes.

The total cost of the plant, including the building, was about £18,000, while the operative economies effected show a saving of £3,000 per year, of which about one-half is due to the saving in fuel, and the balance in reduction in labour and other charges. This is about what has been shown in other cases, and in general it is well to bear in mind that the fuel cost in a steam power plant is generally about one-half the total operative costs, so that any ordinary saving in fuel affects the cost in about that proportion.

# THE MONT BLANC ELECTRIC RAILWAY.

PLANS FOR THE CONSTRUCTION OF THE FIRST SECTION OF THE LINE FROM LE FAYET TO THE SUMMIT.

*Col. G. Espitallier—Génie Civil.*

IT is not so many years ago that the ascent of Mont Blanc was considered a feat to be accomplished only be expert Alpinists with the assistance of professional guides, and even now the ascent can be made only under official regulations, intended to enhance the safety of the traveller and the revenue of the natives. All this is now to be changed, and following the example of the Jungfrau, Mont Blanc is to acquire an electric railway by means of which the tourist may ride in ease and comfort to the summit, at a fraction of the cost of the former ascent. From an account of the plans which have been adopted for the construction of this line, in a paper contributed by Lieut. Col. Espitallier to a recent issue of *Le Génie Civil*, we make some abstract and review.

A concession made by the general council of the department of Haute-Savoie to the railway company, having been approved by the French government on August 3, 1904, plans are now being made for the immediate construction of the first section of the railway, extending from Fayet and Saint Gervais to the Aiguille du Goûter, a point situated at an altitude of 3,840 metres above sea level. The height of the summit of Mont Blanc being 4,810 metres (15,781 ft.) above sea level, it will be seen that this first portion will bring the traveller within 1,000 metres of the summit, leaving the balance of the height to be achieved by a subsequent section. Although the altitude to be scaled by the proposed railway will exceed by far that of any of the Swiss mountain lines, it is but 135 feet higher than that of the tunnel through the Andes, traversed by the trains of the Lima and Oroya Railway in Peru, so that the mere question of altitude offers no problems which have not already been successfully solved.

The first plan for the mechanical ascent of Mont Blanc was made by an able engineer, M. Issartier, in 1895, this unique proposition including a horizontal tunnel into the mountain, and a vertical shaft of about 2,000 metres height. The cost of this plan led to a modification, the entrance of the tunnel being placed at Houches, and the height of the vertical shaft being reduced to 1,000 metres. It was believed, however, that the prospect of making the greater part of the trip underground would render it unattractive to travellers and the scheme was abandoned. A subsequent plan, proposed by M. Souleyre, provided for a continuous ascending grade, but the steepness of the route selected was considered objectionable. The later propositions appear to have settled down into two variants, one starting the railway from the village of Houches, midway between Fayet and Chamonix, and combining the use of a tunnel and steep grades, while the other, by way of Le Fayet and Saint Gervais, employs more moderate grades, and enters the tunnel only towards the summit.

It is this latter plan which has been definitely adopted for the road about to be built, and there is every reason to believe that the scheme will be successfully executed in accordance with the route which has been determined. This line will be 18.5 kilometres long from Le Fayet to the Aiguille du Goûter, while the completed route to the summit of Mont Blanc will prolong this to 22.5 kilometres, or about 14 miles. By making the ascent over a course of this length the grades are kept within satisfactory limits, ranging from 9 per cent. to 23 per cent., and by far the greater portion of the route is open to the sky, the tunnels being near the end of the first section, as the Aiguille du Goûter is approached, the principal tunnel being about 2¾ kilometres in length, preceded by three shorter tunnels.

The route will sweep around the southern side of the mountain, encountering no very serious obstacles, and giving a succession of impressive views of the scenery of the region, and it will doubtless be found that the numerous points along the line will be developed into resorts for pleasure and health seekers. In the tun-

nels themselves the example of the Jungfrau railway will be imitated, openings through the side of the galleries being provided, with protected balconies at the station, permitting the travellers to descend and obtain, in perfect safety, views which can now be enjoyed only at great risk and cost.

In regard to the operative portion of the line, the experience which has already been had with the opened section of the Jungfrau railway has been considered, and the general details will doubtless include the most successful elements of that line. The track will be of one metre gauge, the loading gauge being also the same as on the Jungfrau line; 2.90 metres in height, and 2.50 metres wide. The rails chosen weigh 20 kilogrammes per metre, with steel sleepers, the rack, of the Strub type, being placed between the rails. It is intended to use the three-phase system of electric driving, with locomotives provided with two independent motors, as on the Jungfrau line, the current at first to be provided by some of the existing hydro-electric stations available, although an independent generating station may be constructed later.

From an engineering point of view, as has already been stated, there appears to be no reason why the Mont Blanc railway may not be successfully constructed and operated. Statistics of the mountain railways of Switzerland are given which show returns of more than 5 per cent. on the capital invested, while the development of the tourist business of the district naturally appeals to the same capitalists. There has been some opposition on the part of those whose æsthetic sense is offended at the idea of the profanation of the natural beauty of the locality by so prosaic thing as a railway, but experience has shown in other cases that the insignificant appearance of the track and vehicles, in the midst of such enormous masses of rock, ice, and snow, is a sufficient answer to such objections. The introduction of electric traction removes any annoyance from smoke or puffing of engines, and there can be no more real objection than might be advanced against any other method of making the ascent.

## ENGINEERING IN THE FOUNDRY.

THE APPLICATION OF SCIENTIFIC PRINCIPLES OF OPERATION TO THE WORK OF THE FOUNDRYMAN.

*Robert Buchanan—British Foundrymen's Association.*

THE American Foundrymen's Association has won for itself honorable recognition as an important element in the work of engineer and manufacturer, and we are glad to note that there has been organized in Great Britain a British Foundrymen's Association, to unite the workers in iron into an organization which we trust will be an important element in the development of British industry.

The presidential address of Mr. Robert Buchanan, already well known to our readers by his valuable contributions to our pages, is an excellent indication of what may be expected from the new organization, and we make some abstracts of his address as indicative of the aims and ideals of the society.

The foundry has always been considered as a dirty and somewhat undesirable part of a machine works, and Mr. Buchanan does well to begin by declining to apologize for being a foundryman. As a matter of fact those who regard the foundry as an inferior portion of the works simply reveal their own ignorance of the high demands which foundry operations make upon the skill of the man to whose care this department of engineering is entrusted. Properly considered, the foundryman must be at the same time a mechanic, a metallurgist, and an engineer, and upon the skill with which he exercises his functions depends much of the success of the establishment to which he belongs.

Mr. Buchanan refers, in the opening portion of his address, to the subject of technical education, as related to the work of the foundryman, emphasizing the importance of proper elementary training, in order that coming generations may be able to avail themselves of the opportunities which are being prepared for them in the acquirement of technical education.

Passing from possible opportunities in the future, Mr. Buchanan plunges into the main subject of his address, the study, by the men in the foundry, of the phenomena daily occurring before their very eyes. The work of the foundryman consists in the melting of certain metals, or combination of metals, and the pouring of them into moulds which he has prepared. He deals with the phenomena which are seen in the heating, melting, and cooling of metals, and he has unparalleled opportunities of observing these phenomena. The theories which have been proposed concerning these things are numerous, but very few of the men who have propounded theories have had a fraction of the opportunities of observing these phenomena as have the men whose daily work lies in the foundry. Mr. Buchanan urges the foundrymen to avail themselves of their opportunities, and to study the things with which they have to deal daily, and learn to apply, confirm, or reject theory in the light of their own practical experience.

In order to discuss the behaviour of metals in passing from the liquid to the solid state, Mr. Buchanan compares them to the action of a solution of salt in water. Solutions, of various degrees of concentration, when cooled until solidification takes place, show that there are various elements, with different points of solidification. Similar actions occur with metals, and in the case of cast iron we may consider the material as a solution of carbon in pure iron, much as the salt was dissolved in the water. Upon this analogy the theory of eutectics, and the successive solidification of the various alloys of iron and carbon, is discussed, showing that all the elements contained in the material must be considered, and then no one of them can be assumed to be in a condition of separateness from the other elements.

Having thus shown the necessity for the consideration of all the elements contained in the metal with which the foundryman has to deal, Mr. Buchanan takes up the several elements separately, and examines the properties of silicon, manganese, phosphorus, and sulphur, showing the influence which they have upon the product, and the manner in which they should be treated.

Space will not permit us to discuss in detail the influences of the various elements met in the various grades of cast iron, as discussed by Mr. Buchanan, but the mere fact that a knowledge of such subjects is considered as important or necessary for the foundryman, shows the advance which has been made in this department of engineering work. Formerly a foundryman was considered but little removed from the status of a laborer, but now it is evident that he may aspire to a branch of metallurgical knowledge of recent development, but intensely practical and commercial importance.

A cupola man is now expected to be able to mix metal for definite classes of castings and temperatures, and he is supposed to have positive knowledge of his work, and not to be dependent upon guess work or empirical rules or methods. This means a distinct advance in the status of the foundryman's work, and with it must come a corresponding advance in the returns which it can give to the men who have the necessary information and ability.

The transformation which has taken place in the work of the machine shop and the iron works may be expected to enter also into the foundry, and the result must be a corresponding transformation in the status of the men who are to work on the moulding floor and before the cupola. Muscular labor will be more and more superseded by machinery, and the foundryman who is to survive must learn to use his head the more as he uses his hands the less, and his own position will be improved proportionally. A process of sifting out must go forward and those who survive will be those who have fitted themselves for the higher departments of the work, while the mere routine workers, who have neglected to keep themselves abreast with the progress of the times, will find themselves left behind in the movement. The formation of the British Foundrymen's Association is a hopeful sign of the times, and the character of the address of their President is an excellent indication of the aims and aspirations of the society. We wish them every success, and believe fully in the mission which is before them, the development of the work of the foundryman as one of the essential departments of modern engineering.

# METHODS OF TESTING GAS ENGINES.

## QUANTITATIVE DETERMINATION OF THE HEAT REJECTED IN THE EXHAUST GASES AS A MEASURE OF EFFICIENCY.

*B. Hopkinson—British Association for the Advancement of Science.*

IN determining the thermal efficiency of a heat engine it is necessary to find out what proportion of the heat supplied is returned in actual work. This means the accurate measurement of the heat supplied and the work produced, and it is upon the accuracy with which these two measurements are made that the value of the test depends. In the case of the steam engine the power is measured by the indicator, by some form of absorption brake, or by transformation and measurement as electric current, while the heat supplied is determined from measurements of the water evaporated by the boiler at determinate pressures and temperatures, or by measurement of the steam supplied. In some cases the quantity of steam consumed is measured by collecting the water produced by the condensation of the exhaust steam, and sometimes all three measurements are made.

The internal-combustion offers certain difficulties in testing, but these are being overcome as closer attention is being directed to the comparative efficiencies of different types and models. In those engines which are regulated by the hit-or-miss system of governing, great care must be taken to use indicator diagrams which represent the actual number of working impulses for a given time, but this source of uncertainty has been met by the use of continuous indicators, which give a series of diagrams extending over any desired length of time. The net power is readily measured by absorption dynamometers, or by conversion into electrical energy, while the heat supplied is generally determined from the quantity of gas supplied, and its calorific value. The heat carried off by the jacket water is capable of very accurate determination by the taking of its rise in temperature and its volume, and the usual method of stating the thermal balance of a gas engine is to give the heat returned as work, the heat carried off by the jacket water, and the heat rejected in the exhaust gases. In nearly every case, however, this last quantity is not measured, but is determined by difference, as a chemist would say, the assumption being made that all the heat which does not appear either in work or in the jacket water must necessarily pass out with the exhaust. This plan is open to several objections, the principal one being that it prevents any check upon the work, while if all the elements of the heat balance were measured independently the account might be scrutinized with the same precision as a bookkeeper balances his cash.

The real reason why the heat in the exhaust gases has been deduced instead of being measured lies in the fact that no convenient and accurate method of making the measurement had until recently been devised. At the recent meeting of the British Association for the Advancement of Science a paper was presented by Professor B. Hopkinson, describing a form of calorimeter through which the exhaust gases may be passed and the heat abstracted and measured, thus enabling a complete heat account to be obtained, lacking only the small losses due to conduction and radiation. Professor Hopkinson gives an account of the construction and application of this apparatus in connection with a test of small Crossley gas engine in the Engineering Laboratory, Cambridge, using Cambridge coal gas as fuel.

"The calorimeter for the exhaust gases consists of a section of flanged cast-iron pipe fitted with baffle-plates, by which the gases are caused to pass several times backwards and forwards through its length, and finally to bubble through the water collected at the bottom. The water, after passing through the jacket surrounding the calorimeter, meets the exhaust gases in a fine jet, and is partly caught by them and carried round with them, and partly trickles down the baffle-plates. It was found that in this way the gases could be cooled, with the engine fully loaded, down to 120 degrees F. or less, the cooling water rising in temperature from about 60 degrees to 90 degrees. This instrument was designed of ample proportions, so that it should be cer-

tain to work satisfactorily; there can be no doubt that it is big enough to serve for a much larger engine. In a test on an engine of double the power the calorimeter was very much smaller and the results quite satisfactory.

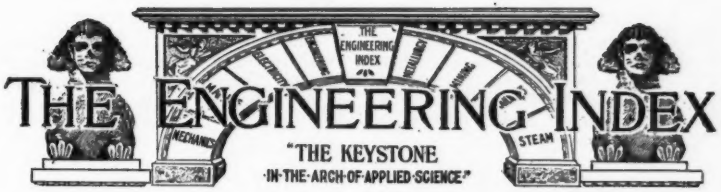
"There is no need to particularise the methods of indicating the engine, or of measuring the amount of temperature rise of the jacket water, about which there was nothing peculiar. Some pains, however, were taken to secure accurate measurement of the heat put into the engine. The gas was measured with a wet and dry meter in series, and both meters were calibrated with a standard holder at the rate of flow of gas actually used. The calorific value of the gas was determined with a Junker calorimeter at the time of the test of the engine."

The results of the tests are tabulated in the paper, but as the engine was of an old model and no high degree of efficiency was expected, these are of moderate interest, except in connection with the matter of the distribution of the losses. In general the results of the earlier methods are fairly well confirmed, but there is a portion of the heat unaccounted for, which shows the desirability of the use of just such a method of investigation. Undoubtedly a portion of this loss is due to conduction and to radiation, and some is probably involved in the impossibility of absorbing all the heat in the exhaust gases. Professor Hopkinson shows that the difference unaccounted for in his first trials ranged from 8 to 16 per cent. of the total amount of heat supplied, an amount too great to be assumed as lost in conduction and radiation, but a second series of trials upon a larger engine gave more satisfactory results. Thus 26 per cent. appeared in indicated work, 32 per cent. in the jacket water, and 34.5 per cent. was measured in the exhaust calorimeter, leaving 7.5 per cent. unaccounted for, of which it is estimated that 1.5 per cent. passed up the chimney, leaving 6 per cent. for all other losses. Professor Hopkinson points out that this is as close an agreement as is obtained in steam engine tests in which the greatest precautions are taken to guard against heat losses, while with improvements in the details of the calorimeter design it is believed that still more accurate results may be expected. In the course of the discussion Professor Schröter, of Munich, stated that a similar apparatus in Germany enabled all but 2 or 3 per cent. of the heat in the balance to be accounted for.

An important point made by Professor Hopkinson was the fact that the measurement of the heat discharged with the exhaust might be more accurately made than the determination of the calorific value of the gas.

"One object of these trials was to ascertain whether a practical method of testing gas-engines for efficiency could be based on the calorimetry of the exhaust gases. At the present time manufacturers are mainly concerned with making their engines reliable; the thermal efficiency, being with any design far and away better than in the steam-engine, is a secondary consideration. But it cannot be doubted that in the future gas-engines will have to be as closely tested for efficiency as steam-engines now are. Now to measure the heat put into a large engine worked with producer gas is a very difficult and costly undertaking. The volume of gas is very great, and its quality may vary largely in the course of a day's trial. It seems that it may be easier and more accurate to measure the indicated work and the heat rejected, as is usually done in testing a steam-engine. One large part of the rejected heat—that is, the heat in the jacket-water—presents no difficulty; we have therefore only to measure the heat carried away in the exhaust gases."

While it may be of interest to find another method of determining the efficiency of the gas engine, it is undoubtedly far more desirable that all the elements in the computation shall be measured, in order that an accurate check may be kept upon the whole. For this reason it is to be hoped that the use of the exhaust calorimeter will not be permitted to prevent the efforts to determine the calorific value of the fuel, the measurement of the power, nor the independent measurement of the jacket losses, since any computation by difference should be avoided whenever possible, this rule holding good both for the mechanical and the chemical laboratory.




The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

*We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger division of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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# CIVIL ENGINEERING

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**Australia.**

The Sydney Harbor Bridge, Australia. Illustrated description of the accepted design of a proposed bridge over Sydney Harbor. 1700 w. Eng News—Sept. 22, 1904. No. 65087.

**Design.**

Design in Relation to the Durability of Bridges. A discussion of this subject, illustrating by a comparison of two modern bridges across the Thames, England. 2200 w. Engr, Lond—Sept. 16, 1904. No. 65250 A.

**Highway.**

Highway Bridges. C. M. Canady. Considers some of the types and details which have claimed the attention of designers during the past twenty years. General discussion. 4500 w. Pro Engrs Soc of W Penn—June, 1904. No. 65050 D.

**Mexico.**

The Tula and the Chone River Bridges, Mexico. Illustrated descriptions. 1500 w. Eng Rec—Sept. 24, 1904. No. 65226.

*We supply copies of these articles. See page 319.*

**Pittsburg.**

The Erection of the Tenth Street Bridge, Pittsburg. An illustrated detailed description of methods used in erecting a bridge carrying highway and street car traffic across the Monongahela River. 2000 w. Eng Rec—Aug. 27, 1904. No. 64737.

**Plate Girders.**

Plate Girder Webs. A discussion of the best method of finding the right thickness for the web of any given girder. 5000 w. Engr, Lond—Sept. 9, 1904. No. 65041 A.

**Reconstruction.**

Bridge Renewal Under Unusual Conditions. Illustrates and describes the methods used in renewing the drawbridge on the New York, Chicago & St. Louis Ry. at Lorain, showing the difficulties of the work and how they were overcome. 1100 w. Eng News—Sept. 22, 1904. No. 65090.

The New Main Span of the Plattsmouth Bridge. An illustrated detailed description of improvements made in a bridge crossing the Missouri River in order to provide for heavier loads and increasing traffic. 2700 w. Eng Rec—Aug. 27, 1904. No. 64731.

The Reconstruction Works Upon the Mont Blanc Bridge at Geneva (Les Travaux de Réfection du Pont du Mont Blanc à Genève). George Autran. An illustrated account of the placing of a new superstructure upon the piers of the bridge over the Rhône. 1800 w. Schweiz Bauzeitung—Sept. 3, 1904. No. 65179 B.

**Reinforced Concrete.**

Reinforced Concrete Bridge Over the Jesenica near Reka (Betoneisenbrücke über den Jesenicabach bei Reka). Gustav Hermann. Illustrating the construction of a Melan arch of 19 metres span in Southern Austria. 2000 w. 3 plates. Oesterr Wochenschr f d Oeffent Baudienst—Sept. 10, 1904. No. 65189 D.

Reinforced Concrete Highway Bridges in New Jersey. Illustrates and describes bridges over the Passaic River in the vicinity of Paterson. 2500 w. Eng Rec—Sept. 10, 1904. No. 64935.

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**Suspension.**

The Bridges of the Haut-Ogoône Company in the French Congo (Les Ponts du Haut-Ogoône dans le Congo Français). Lieut. Col. Giselard. An account of the simple system of suspension bridges over the rivers on the route between Alembé and Lélédi. 3000 w. 1 plate. Génie Civil—Aug. 27, 1904. No. 65118 D.

The New Manhattan Bridge. A short sketch of the history of this bridge, with an illustrated description of the design as approved by the Municipal Art Commission. 1200 w. Archts' & Bldrs' Mag—Sept., 1904. No. 64891 C.

The Theory of the Stiffened Catenary with Increased Horizontal Tension (Beitrag zur Theorie der Versteiften Kette mit Aufgehobenem Horizontalzuge). Prof. Ramisch. A graphical and analytical study, showing the effect of temperature changes. 1800 w. Oesterr Wochenschr f d Oeffent Baudienst—Aug. 13, 1904. No. 65186 D.

The Williamsburg Bridge over the East River in New York (Die Williamsburg-Brücke über den East River in New York). K. Bernhard. A very fully illustrated account of the new bridge, showing its location and construction, with details of the erection. Two articles, 6000 w. Zeitschr d Ver Deutscher Ing—Aug. 13, 27, 1904. No. 65101 each D.

**Uganda.**

American Bridge Building in Equatorial Africa. An illustrated detailed description of the construction of the bridges on the Uganda Railway, in Central Africa. 3300 w. Eng Rec—Sept. 3, 1904. Serial. First part. No. 64811.

## CONSTRUCTION.

**Building Construction.**

The Equipment and Construction of the Phipps Power Building at Pittsburg. Gerald E. Flanagan. Illustrated description of a building designed to furnish power in various forms from a central station to a group of buildings adjacent. 4000 w. Ir Trd Rev—Sept. 15, 1904. No. 64990.

The Phipps Power Building. Gerald E. Flanagan. An illustrated detailed description of a building and its equipment, designed to furnish power in various forms to a group of buildings adjacent. 4000 w. Pro Engrs' Soc of W Penn—Aug., 1904. No. 65055 D.

**Columns.**

Raising 90-Ton Columns at the Cathedral of St. John the Divine, New York City. Illustrations with brief description of the method used. 500 w. Eng News—Sept. 1, 1904. No. 64793.

**Dams.**

A Proposed Earth Dam with a Steel Core and a Reinforced Concrete Spillway at Ellsworth, Me. J. A. Leonard. Brief description, with illustrations. 400 w. Eng News—Sept. 22, 1904. No. 65089.

Timber Dam at the Outlet of Chesuncook Lake, Penobscot River. J. W. Tower. Illustrates and describes the construction. 800 w. Eng News—Sept. 1, 1904. No. 64795.

**Ditcher.**

The Buckeye Traction Ditcher. Frank

C. Perkins. Illustrated description of a labor-saving device, designed to cut trenches and ditches. 1500 w. Sci Am—Sept. 10, 1904. No. 64917.

**Fireproofing.**

Notes on Fireproofing City Buildings. Perez M. Stewart. Extracts from a paper on "The Fire Resistance of Modern High Buildings," read before the International Assn. of Fire Engineers, at Chattanooga, Tenn. Considers the horizontal, vertical and exposure hazards, substituting for wood, incombustible furnishings, etc. 3000 w. Engs News—Sept. 22, 1904. No. 65091.

**Foundations.**

Chicago Foundations. James N. Hatch. Describes the condition of the soil and the types of foundation which have become standard. Ills. 3000 w. Archts & Bldrs' Mag—Sept., 1904. Serial. 1st part. No. 64892 C.

Concrete Pile Foundations at Washington Barracks, D. C. Capt. John Stephen Sewell. Describes the foundation difficulties encountered and the means adopted for overcoming them. Ills. 2800 w. Eng Rec—Sept. 24, 1904. No. 65225.

Constructing the Foundations of the Trinity Building, New York. Illustrated description of difficult foundation work in the City of New York, adjacent to Trinity Church grounds, and to the elevated railway. 4000 w. Eng Rec—Sept. 3, 1904. No. 64815.

Derricks and Sheet Pile Drivers for Foundation Work. Illustrates and describes the foundation work of the new Trinity Building, in New York, and the machinery for meeting the difficulties. 2000 w. Eng Rec—Aug. 27, 1904. No. 64734.

Foundations of the Power House of the New York Rapid Transit R.R. Information concerning the massive foundations required to support a steel superstructure 125 feet high, containing a great amount of very heavy machinery. 1500 w. Eng Rec—Aug. 27, 1904. No. 64736.

**Reconstruction.**

Replacing Girders in a Lower Story of a High Office Building. Illustrated detailed description of work carried out in enlarging the N. Y. Times Building, on Park Row, New York. 3000 w. Eng Rec—Sept. 24, 1904. No. 65230.

**Reinforced Concrete.**

Considère's Theory of Reinforced Concrete in the Light of Recent Beam Tests. Reviews Mr. Considère's experiments and conclusions, and the light thrown on this subject by the recent tests of Prof. A. N. Talbot, and of Prof. F. E. Turneaure. 1600 w. Eng News—Sept. 15, 1904. No. 64983.

Flexure of Reinforced Concrete Beams. Arthur N. Talbot. A summary of tests made in the Laboratory of Applied Mechanics of the University of Illinois, discussing some of the analytical phases of the resistance of such beams to flexure. Ills. 7500 w. Jour W Soc of Engrs—Aug., 1904. No. 65095 D.

Reinforced Concrete. John Monash. Read before the Royal Victorian Inst. of Archts. An explanation of the principal characteristics of this construction, and some of its applications. 3000 w. Archt, Lond—Sept. 16, 1904. No. 65236 A.

Tests of Reinforced Concrete Beams. Prof. F. E. Turneaure. Read before the Am. Soc. for Test. Mat. Describes investigations made of the strength of beams reinforced by different methods and loaded in different ways. 2400 w. Eng Rec—Sept. 3, 1904. No. 64810.

Tests of the Siegwart Beam (Erprobung von Siegwart Balken). F. Schule. Describing tests of a special form of reinforced concrete beam upon a testing machine arranged for distributed transverse loads. 1000 w. Schweiz Bauzeitung—Aug. 27, 1904. No. 65178 B.

See also Civil Engineering, Bridges.

**Roads.**

Road Construction on the Island of Cyprus. Describes the making and maintenance of roads in an island where traffic is by diligences and vehicles not weighing much more than 2 tons when loaded. 1500 w. Eng Rec—Aug. 27, 1904. No. 64738.

**Tunnels.**

The First Street Tunnel at Washington. Begins an illustrated description of the construction work of the tunnels for the passenger trains of the Pennsylvania R. R. by which they will reach the new Union Terminal Station. 1600 w. Eng Rec—Sept. 3, 1904. Serial. 1st part. No. 64809.

The Simplon Tunnel (Le Tunnel du Simplon). Pierre de Blonay. A detailed account of the work from July 1, 1903, to June 30, 1904, with tables and diagrams of excavation, temperature, ventilation, drainage, etc. 4000 w. Bull Tech de la Suisse Rom—Sept. 10, 1904. No. 65185 D.

The Virginia Avenue Tunnel, Washington. Illustrated description of the construction. 2400 w. Eng Rec—Aug. 27, 1904. No. 64733.

Tunneling with a Shield in London Clay. H. A. Bartlett. Extract from a paper presented to the Inst. of Civ. Engrs., London. Illustrates and describes the

work done by the shield and methods employed. 1500 w. R R Gaz—Vol. XXXVII. No. 14. No. 65001.

**Wind.**

The Tornado of August 20, 1904, at St. Paul, Minn. C. A. P. Turner. Illustrates and describes the effect on buildings and bridges. 1800 w. Eng News—Sept. 1, 1904. No. 64796.

## MATERIALS OF CONSTRUCTION.

**Bricks.**

The Manufacture of Bricks from Destructor Clinker. Illustrates and describes the process of manufacture in the plant installed by the Woolwich Town Council in conjunction with their refuse destructor. 1000 w. Engr, Lond—Aug. 26, 1904. No. 64872 A.

**Cements.**

Hydraulic Limes and Grappier Cements. Edwin C. Eckel. Describes the manufacture and properties of these two cementing products which are closely allied to the natural cements. 2800 w. Munic Engng—Sept., 1904. No. 65048 C.

The Cement-Belt in Lehigh and Northampton Counties of Pennsylvania. F. B. Peck. Read before the Am. Chem. Soc. An illustrated description of the geological formations. 3000 w. Mines & Min—Sept., 1904. No. 64877 C.

Practical Cement Control. Dr. Charles F. McKenna. Condensed from a paper read before the Am. Soc. for Test. Mat. Applies principally to large works, giving specifications and methods of inspection. 2400 w. Eng Rec—Aug. 27, 1904. No. 64732.

## MEASUREMENT.

**Surveying.**

Results Recently Obtained by Métrophotography (Sur Différents Resultats Récemment Obtenus par la Métrophotographie). A. Laussedat. Showing the excellent results in the study of topography by the aid of the Pulfrich stereo-comparator. 1000 w. Comptes Rendus—Aug. 8, 1904. No. 65123 D.

## MUNICIPAL.

**Pavements.**

Brick Pavements in America. Ira O. Baker. Describes the making and testing of the bricks used, the road construction, filling, &c., and gives information as to their merits and cost. Ills. 4200 w. Public Works—Sept. 15, 1904. No. 65033 D.

**Refuse Disposal.**

Description of Refuse Destructor and Electrical Power Generating Station in Course of Erection at Saltley. D. J. Roberts. Illustrates and describes this combined scheme for cremating ordinary refuse and utilizing the heat for raising steam for generating electricity for traction and lighting purposes. 3800 w. Elec Engr, Lond—Sept. 9, 1904. No. 65028 A.

The New Garbage Cremator at Toronto. Illustrated description of a new destructor which combines the Mann, the Thackeray, and the Dixon systems. 1000 w. Eng Rec—Sept. 10, 1904. No. 64940.

The Riker's Island Refuse Conveyor Plant. The refuse from Manhattan, New York, exclusive of garbage, is being used to extend the area of this island, and the plant which has been installed for unloading and distributing the material is illustrated and described. 1500 w. Eng Rec—Sept. 17, 1904. No. 65017.

**Sewage.**

Bacterial Sewage Disposal at Ash, England. Describes these works, which are of interest on account of the conditions under which they were built. 2200 w. Eng Rec—Sept. 24, 1904. No. 65231.

**Sewers.**

An English Fan System of Sewer Ventilation. From a paper by E. George Mawbey, read before the English Assn. of Munic. and Co. Engrs. Describes the writer's experience with the new system of sewer ventilation devised and patented by Messrs. Shone & Ault, with satisfactory results. 2000 w. Eng Rec—Aug. 27, 1904. No. 64735.

**Street Cleaning.**

Street Cleaning in German Cities. Howard Woodhead. Describes the attention given to this branch, the enforced regulations for non-littering of streets, the removal of refuse, and the smooth pavements which make thorough cleaning possible. 2500 w. Munic Jour & Engr—Sept., 1904. No. 64908 C.

## WATER SUPPLY.

**Croton Dam.**

Completing the New Croton Dam. Illustrations, with description of construction work on the dam for the New York water supply. 1600 w. Sci Am—Sept. 24, 1904. No. 65083.

Recent Progress on the New Croton Dam. An illustrated account of work on this dam which is to impound an additional water supply of 32,000,000,000 gals. for New York City. 3800 w. Eng Rec—Sept. 10, 1904. No. 64939.

**Distribution.**

Multiple Zone Distribution for Municipal Water Supply (Mehrfache Versorgungszonen für städtische Wasserleitungen). Rudolf Müller. Showing the advantages of dividing the area into several zones of various levels, with supplies of

corresponding pressures. 2000 w. Oesterr Wochenschr f d Oeffent-Baudienst—Aug. 20, 1904. No. 65188 D.

**Filters.**

The Open Sand Filters for the Providence Water-Works. An illustrated detailed description of this plant. 3000 w. Eng Rec—Sept. 24, 1904. Serial. 1st part. No. 65224.

**Irrigation.**

The Irrigation Works of the Modesto and Turlock Districts, Cal. The first of a series of illustrated articles giving a descriptive account of the engineering work. 2000 w. Eng Rec—Sept. 17, 1904. Serial. 1st part. No. 65014.

**Komotau.**

The Water Supply of the City of Komotau (Die Wasserversorgung der Stadt Komotau). J. A. Spitzer. Illustrating and describing the construction of the dam, aqueduct, and filter plant for the city of Komotau, in Bohemia. Two articles, 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 12, 19, 1904. No. 65150 each D.

**Obstructions.**

Incrustations, Deposits and Organic Growths in Pipes and Other Water Conduits. Excerpt from a paper by James C. Brown, presented to the Inst. of Civ. Engrs. Considers incrustations in unprotected iron pipes, and deposits and growths depending on the composition of the water. 1200 w. Eng News—Sept. 22, 1904. No. 65088.

**Reservoirs.**

Cleaning a Water-Works Reservoir by Dredging. F. B. Marsh. Describes apparatus and methods used in cleaning reservoir No. 1, in Pittsburg, and the cost. 1200 w. Eng Rec—Sept. 3, 1904. No. 64814.

**Supervision.**

The Supervisory Control of Water Supplies in Great Britain. James Robert Kaye. Read before the Sanitary Inst. in Glasgow. A discussion of the various proposals for supervisory control, especially describing the practice of the Derwent Valley Water Board. 2500 w. Eng Rec—Sept. 17, 1904. No. 65015.

**Water Treatment.**

Copper Sulphate Treatment of Lakes Clifton and Montebello, Baltimore Water Works. Alfred M. Quick. Two low-service storage reservoirs became troubled with algae, and the treatment given and method of application is described. 1500 w. Eng Rec—Sept. 24, 1904. No. 65229.

The Use of Sulphate of Copper for the Destruction of Algae in Reservoirs (Emploi der Sulfate de Cuivre pour la Destruction des Algues dans les Réservoirs d'Eau Potable). A review of the proposed method of purifying water by sulphate of copper. 2000 w. Génie Civil—Aug. 13, 1904. No. 65115 D.

## WATERWAYS AND HARBORS.

**Canal Lift.**

A novel Canal Lift at Foxton. Illustrates and describes a system devised by Gordon & James B. Thomas, of England, for abolishing locks and raising and lowering boats by mechanical means. 1500 w. Sci Am—Sept. 3, 1904. No. 64758.

**Cape Town.**

Cape Town Harbor Works. R. H. Hammersley-Heenan. An introductory review of the early history of this southern point of the African Continent, and early engineering work there, with illustrated description of recent work. 7400 w. Public Works—Sept. 15, 1904. No. 65032 D.

**Flow.**

Recent Russian Studies of Flow in Rivers. Translation of interesting parts of the work describing Professor Tiapkin's hydraulic experiments. 3300 w. Eng News—Sept. 1, 1904. No. 64794.

**Nile.**

Nile Irrigation. Sir Hanbury Brown. A discussion of the problem of providing for the continued development of Egypt and the reclamation of the Soudan at the same time, based on the recent report of Sir William Garstin. Map. 6000 w. Engr, Lond—Sept. 9, 1904. Serial. 1st part. No. 65039 A.

The Irrigation Development of Egypt—A Huge Project. Outlines the scheme formulated by Sir William Garstin for improving the channels of the White Nile and the Blue Nile, the Nile Delta, &c., and so rendering fertile thousands of acres of land now sterile. 1200 w. Sci Am Sup—Sept. 10, 1904. No. 64922.

**River Improvement.**

Navigation on the Rivers of the Pacific Northwest. The work of the government in improving the Columbia, Snake and other rivers of Oregon, Washington and Idaho, with illustrations of the type of steamboats employed on these streams. 1500 w. Naut Gaz—Sept. 8, 1904. No. 64932.

**Zeebrugge.**

The Harbor Works at Zeebrugge (De Havenwerken te Zeebrugge). W. Meijer Timmerman Thijssen. Showing the new curved breakwater, and channel through the bar at the port of Zeebrugge, Holland. 2000 w. De Ingenieur—Aug. 13, 1904. No. 65184 D.

*We supply copies of these articles. See page 319.*

# ELECTRICAL ENGINEERING

## COMMUNICATION.

**Alaska.**

Building the Alaskan Telegraph System. Capt. William Mitchell. A description of some of the difficulties met and conquered. 3300 w. Nat Geog Mag—Sept., 1904. No. 64893 C.

**Automatic.**

The Automatic v. the Manual Telephone Exchange. Kempster B. Miller. An examination of some of the phases as they appear to the writer, with comments. 3700 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65289 D.

The Automatic Telephone System at Los Angeles, Cal. P. K. Higgins. Illustrated description of the new equipment of the Home Telephone and Telegraph Company. 3800 w. Elec Rev, N Y—Sept. 3, 1904. No. 64828.

**Battery System.**

Features of the Dunbar Two-Strand Common-Battery Systems. Prof. J. C. Kelsey. Briefly considers the features of the various commercial systems and the advance made by the Dunbar systems. Ills. 3000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65293 D.

**Cables.**

A New Danger to Lead-Covered Aerial Cables. John Hesketh. Describes trouble caused by an insect in Queensland which attacks the telephone cables. Ills. 2500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65288 D.

Some Recent Long-Distance Submarine Telephone Cables. F. Breisig. Abstract of a paper read before the Elektrotechnischer Verein of Berlin. An illustrated article describing the Fehmarn-Lolland, the Greetsiel-Borkum, and the Cuxhaven-Heligoland cables. 2000 w. Elect'n, Lond—Sept. 2, 1904. No. 64959 A.

Submarine Cables (Les Cables Sous-marins). G. Couraud. Describing modern methods of cable laying, illustrating the practice of different countries. Serial, Part I. 3000 w. Revue Technique—Aug. 25, 1904. No. 65128 D.

The Alternating-Current Theory of Transmission-Speed over Submarine Telegraph Cables. Prof. A. E. Kennelly. Mathematical treatment, showing the importance of the receiving-end impedance. Also bibliography and appendix, with table of hyperbolic functions of semi-imaginary quantities. 9000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65331 D.

**Double Service.**

Simultaneous Telegraphy and Telephony. Joseph Hollos. Outlines the principles which were followed in the formation of the Hungarian system, which shows good results. 1500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65282 D.

The Malcotti Telecryptograph for Telegraphing upon Telephone Lines. Emile Guarini. Remarks on recent efforts to popularize the telegraph for private use, and to insure privacy on telephone lines, with illustration and information concerning the instrument which claims to have solved the problem. 1700 w. Sci Am—Sept. 17, 1904. No. 64985.

**Exchanges.**

A Progressive Western Telephone Exchange. H. K. Sprague. An illustrated description of the new telephone exchange at Boulder, Colorado. 3800 w. Am Elect'n—Sept., 1904. No. 64843.

Theory of Telephone-Exchange Development. G. de la Touanne. A summary of the principal commercial questions met in starting a new telephone exchange. 4000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65286 D.

The New Telephone Exchange at Budapest (Die Neue Telephoncentrale in Budapest). P. von Szalay. With views of the building, together with switchboard and connections made by the Western Electric Co. after a competition with Swedish, French, German, and American firms. 2000 w. Elektrotech Zeitschr—Sept. 8, 1904. No. 65162 B.

**Fire Alarm.**

Electric Fire Alarm System for Warehouses and Theatres (Elektrische Feuer-Alarmanlagen in Warenhäusern und Theatern). K. Miram. The apparatus sounds the alarm and indicates the nearest exits when the alarm button at any point is pressed. 2000 w. Elektrotech Zeitschr—Sept. 15, 1904. No. 65166 B.

**Japan.**

Telegraphy and Telephony in Japan. Saitaro Oi. Reviews the development in Japan, and the present situation. Ills. 4300 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65280 D.

**Military Service.**

Signal Service in Modern Warfare. M. C. Sullivan. Describes methods used by the Japanese army in the war now in progress, especially the extensive use of the

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telephone. Ills. 1500 w. Sci Am—Sept. 10, 1904. No. 64920.

The Telegraph, Telephone and Cable in War. Maj. Samuel Reber. A general description of the service and its value in modern warfare, with review of its early history. 4000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65291 D.

**Multiple Transmission.**

Harmonic Telegraph. Prof. Ferdinando Lori. Brief explanation of a multiple transmission system based on this principle. 500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65287 D.

**Printing Telegraphs.**

Modern High Speed Printing Telegraph Systems. J. C. Barclay. General discussion with brief descriptions of the Murray, Rowland, and Buckingham systems. 3500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65294 D.

Printing Telegraphy. Dr. Louis M. Potts. Treats of the various essential principles involved in the systems which have been shown to be of practical value. 4500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65281 D.

The Keyboard of the Hughes Telegraph (Die Klaviatur des Hughes-apparates). G. Conradt. Discussing the arrangements of the keyboard of the Hughes printing telegraph to give the best efficiency in different languages. 2000 w. Elektrotech Zeitschr—Aug. 25, 1904. No. 65158 B.

**Relays.**

The Problem of the Telephone Relay. Dr. John Trowbridge. An account of an instrument produced by the writer, and the character of its working. 1000 w. Elec Rev, N Y—Sept. 10, 1904. No. 64946.

**Space Telegraphy.**

A New System for Securing Secrecy in Wireless Telegraph Signaling. Emile Guarini. Discusses the transmitting and receiving system devised by M. Blondel, in France, and Prof. Artom, in Italy. 2200 w. Sci Am Sup—Sept. 17, 1904. No. 64988.

Electrolytic Receivers in Wireless Telegraphy. Dr. Lee de Forest. Briefly reviews the field of cohering indicators of electric waves, and calls attention to researches leading to forms of sensitive receivers, adaptable to most of the demands of wireless telegraphy. 6000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65290 D.

The Present State of Wireless Telegraphy. Prof. J. A. Fleming. A broad general statement of the present state of the art. 12000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65284 D.

The Tuning of Space Telegraphic Transmitters (Die Abstimmung Funkentelegraphischer Sender). A. Slaby. Discussing methods of increasing the energy capacity of the transmitter wires, and means of regulating the wave-lengths emitted. Two articles, 10000 w. Elektrotech Zeitschr—Aug. 18, Sept. 8, 1904. No. 65153 each B.

**Telegraph Poles.**

Some Causes of the Unequal Durability of Telegraph Poles (Ueber einige Ursachen Ungleicher Dauerhaftigkeit der Telegraphstangen). Karl Havelik. Showing the influence of the character of the wood, the method of preparation, and the system of construction, upon the durability of telegraph poles. 5000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Aug. 20, 1904. No. 65187 D.

**Telegraphy.**

Rapid Telegraphy. Patrick B. Delany. Defines the term as designated by usage, and reviews the various systems, their limitations, and related matters. 5700 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65283 D.

**Telephony.**

High-Frequency Telephone Circuit Tests. Dr. A. E. Kennelly. Describes certain apparatus constructed for the purpose of measuring the alternating-current strength, at telephonic frequencies, received at the distant end of a telephone circuit, with a definite e. m. f. impressed on the sending end. Ills. 4500 w. Int Elec Cong of St. Louis—Sept., 1904. No 65295 D.

Loaded Telephone Lines in Practice. Dr. Hammond Vinton Hayes. A brief statement of the results obtained by the use of loaded coils on many of the telephone circuits of the Bell companies. 3000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65292 D.

The Telephone Problem in Large Cities. F. J. Dommerque. Considers the best service can be rendered in an exchange without trunking, and that the quality deteriorates with increasing percentage of trunking. 3000 w. Int Elec Cong of St. Louis, Sept., 1904. No. 65285 D.

## DISTRIBUTION.

**Autotransformer.**

The Theory of the Autotransformer (Die Theorie des Autotransformators). Dr. Ed. Slovsa. A discussion of the action of transformers in which the change of pressure is effected by the use of a single bobbin system. Serial, Part I. 2500 w. Zeitschr f Elektrotechnik—Sept. 18, 1904. No. 65173 D.

**Cables.**

Eddy-Current Losses in Three-Phase

Cable Sheaths. M. B. Field. Read before the British Assn. Gives calculations of self-induced eddy currents and mutually induced eddy currents. 4000 w. Elec Engr, Lond—Sept. 16, 1904. No. 65240 A.

Experiments on Sheath Losses of Three-Core Cables. J. T. Morris. An account of experiments carried out by the author to determine experimentally the magnitude of some of these losses in cables conveying polyphase currents. 3000 w. Elect'n, Lond—Sept. 2, 1904. No. 64958 A.

**Conductors.**

Computations of the Influence of Capacity, Induction and Resistance upon Aerial or Subterranean Conductors (Berechnung der Einflusse von Kapazität, Induktion, und Resistanz auf Ober oder Unterirdischen Leitungen). E. W. Ehnert. Containing an extensive series of examples relating to various problems with polyphase currents. Three articles, 6000 w. Zeitschr f Elektrotechnik—Sept. 4, 11, 18, 1904. No. 65171 each D.

**Controllers.**

Notes on the Design of Controllers (Weitere Beiträge zum Entwurf von Kontrollern). Robert Edler. Discussing especially the application of cams in the design of controllers for heavy hoisting and conveying machinery. Two articles, 6000 w. Zeitschr f Elektrotechnik—Aug. 21, 28, 1904. No. 65169 each D.

**Cut-Out.**

Circuit-Breakers. W. M. Scott. A discussion of reverse current circuit-breakers and their operation, applications, &c. Ills. 5500 w. Jour Fr Inst—Sept., 1904. No. 65063 D.

**Direct Current.**

The Direct-Current Distributing Systems of American Cities. Alex Dow. Describes the electric distribution system which is commonly in use in the larger American cities, stating the reasons for the adoption and retention of the system, and in a sense justifying the methods of the larger electric light companies. 11000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65307 D.

**Fuses.**

Observations with the Oscillograph upon the Time Required for the Melting of Fuses (Ueber den Zeitlichen Verlauf des Schmelzstromes von Sicherungen Beobachtet mit dem Oscillographen). E. Oelschläger. Giving diagrams showing the time required for melting safety fuses with various currents. 2500 w. Elektrotech Zeitschr—Sept. 1, 1904. No. 65160 B.

**High Tension.**

Protection and Control of Large High Tension Alternating-Current Distribution Systems. George N. Eastman. Examples and conditions presented refer to the system of the Chicago Edison Company and Commonwealth Electric Company, discussing the protection needed. Ills. 3500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65298 D.

70,000-Volt, Direct-Current Tests Made at Genoa, Switzerland. B. F. Hirschauer. An account of important experiments with high voltage distribution on the direct-current system which have been carried out by M. Réné Thury. 4000 w. Elec Rev, N Y—Sept. 24, 1904. No. 65233.

**Net-Works.**

The Distribution of Voltage and Current in Closed Conducting Net-Works. Prof. Clarence Feldmann and Josef Herzog. A demonstration of some simple theorems which explain the manner of dealing with net-works of conductors from the standpoint of the electrical engineer, greatly restricting the application of mathematics. 3600 w. Int Elec Cong of St. Louis—Sept., 1904. No. 64276 D.

**Switch.**

The Automatic Transformer Switch (Der Automatische Transformatorenschalter). J. Schmidt. Describing a device for automatically cutting out the transformers of a distribution system as the demand falls off. 6000 w. Elektrotech Zeitschr—Sept. 15, 1904. No. 65165 B.

**Systems.**

Distributing Systems from the Standpoint of Theory and Practice. Philip Torchio. A review of the systems of distribution, studying the problem by assuming a concrete case, describing the possible lay-outs, &c. Ills. 11000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65308 D.

**Transformers.**

Notes on Experiments with Transformers with Very High Potentials. Prof Harold B. Smith. Description, with illustrations, of a transformer made under the writer's direction, with a statement of the experience with it for the past six years. 2000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65273 D.

**Underground.**

Underground Electrical Construction. Louis A. Ferguson. Describes particularly the drawing in system of cables and conduits, their operations, &c. Ills. 4500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65296 D.

## ELECTRO-CHEMISTRY.

**Anodes.**

The Electrical Properties of the Films

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that Form on Aluminum Anodes. William Roy Mott. Considers these insulating films as regards their specific resistance, insulating strength, and specific inductive capacity. 4000 w. Elec Chem Ind—Sept., 1904. No. 64805 C.

**Battery.**

How to Make a High-Voltage Testing Battery. George T. Hanchett. Directions with illustrations. 1000 w. Am Elect'n—Sept., 1904. No. 64847.

**Carbon Cell.**

The Carbon Cell Considered as a Gas Battery (Das Kohlenelement eine Knallgaskette). F. Haber and L. Bruner. A study of the action of the cell consisting of carbon and iron plates in fused soda. 7500 w. Zeitschr f Elektrochemie—Sept. 9, 1904. No. 65176 D.

The Carbon Cell. Prof. Dr. F. Haber and Dr. L. Bruner. Theory and record of experiments with cells having carbon and iron or platinum electrodes and sodium hydrate electrolyte. 2500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65322 D.

**Cells.**

A Study of the Materials Used in Standard Cells and Their Preparation. George A. Hulett. Considers mercurous sulphate and standard cells. Prof. Henry S. Carhart discusses the preparation of materials and construction of cells. 5700 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65330 D.

**Chlorine.**

Chlorine in Metallurgy. James Swinburne. Describes a process depending on the action of chlorine. The principle is the treating of sulphide ores, without previous roasting, with chlorine, so as to form chlorides of the metals, the sulphur being liberated as such. The chlorides are then electrolyzed, yielding metals and recovering the chlorine. 1600 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65327 D.

Some Notes on the Uses of Electrolytic Chlorine. F. Winteler. Gives suggestions for the manufacture of products other than bleaching powder to utilize the excess of chlorine. 3300 w. Elec Chem Ind—Sept., 1904. No. 64802 C.

**Conduction.**

Electrolytic Conduction. Prof. Joseph W. Richards. The object of the paper is to present the thesis that, as far as the conduction of electricity through the body of the conductor is concerned, there is, as far as can be determined, complete identity between metallic conductors and so-called electrolytic conductors. 2200 w. Int Elec Cong of St. Louis—Sept, 1904. No. 65319 D.

**Electrical Furnaces.**

Some First Principles of Electrical Resistance Furnaces. F. A. J. Fitz Gerald. A study of the principles of these furnaces, their construction and manipulation. 3500 w. Elec Chem Ind—Sept., 1904. Serial. 1st part. No. 64803 C.

**Electrolysis.**

Electrolysis and Catalysis. Prof. Dr. W. Ostwald. Shows what a very essential and important part the catalyzers are able to play in electrolytic action. 3500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65324 D.

The Energon Theory of Electrolysis (Elektrolyse nach der Energon Hypothese). A. Reuterdahl. With diagrams explaining the dynamic theory of electrolytic dissociation. 2500 w. Elektrochemische Zeitschr—Sept., 1904. No. 65175 G.

**Electro-Metallurgy.**

The Electro-Metallurgy of Iron and Steel. A. F. Schneider. Reviews some of the processes which have been successful and are now in use, illustrating and comparing them. 1500 w. Min Mag—Aug., 1904. No. 65202 C.

**Electroplating.**

The Chemistry of Electroplating. Prof. Wilder D. Bancroft. Shows that a study of chemical reactions and chemical analogies will at least give the outlines of a theory of electroplating. 2800 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65321 D.

**Ferro-Alloys.**

The Manufacture of Ferro-Alloys in the Electric Furance. George P. Scholl. Deals only with such ferro-alloys as are manufactured on an industrial scale in practice. The present article reviews the history of their manufacture. 2800 w. Elec Chem Ind—Sept., 1904. Serial. 1st part. No. 64804 C.

**Metals.**

The Electrochemical Series of the Metals. Prof. Louis Kohlenberg. A detailed study of the differences of potential between metals and solutions, showing that it may vary greatly with a change in the solute as well as with a change in the solvent. 2500 w. Int Elec Cong of St. Louis—Sept., 1904—No. 65323 D.

**Nitrates.**

Electrical Extraction of Nitrogen from the Air. J. Sigfrid Edstrom. Reviews the methods proposed for extracting the nitrogen from the air, especially describing the new process by Prof. C. Birkeland and S. Eyde, of Christiana. Ills.

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2800 w. Int Elec Cong of St. Louis—Sept., 1904. No. 64328 D.

**Sodium.**

The Manufacture of Sodium by the Becker Process. C. F. Carrier, Jr. An illustrated critical review of this process as described by the inventor. 2000 w. Elec Chem Ind—Sept., 1904. No. 64807 C.

**Storage Battery.**

The Jungner Nickel-Iron Accumulator and its Origin. M. V. Schoop. Translated from the *Centralblatt für Accumulatoren Technik und Verwandte Gebiete.* An illustrated account of Jungner's work in this field. 3500 w. Sci Am Sup—Sept. 17, 1904. No. 64989.

The Present Status of the Edison Storage Battery. A. E. Kennelly and S. E. Whiting. A brief synopsis of the results obtained with this battery up to the present date. Ills. 4800 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65329 D.

**Zinc Sulphides.**

Electrolytic Production of Zinc and Lead from Complex Sulphide Ores., Charles H. Burleigh. On the treatment of refractory zinc sulphides, giving facts which have been tested and proved on a commercial scale. 3000 w. Elec Chem Ind—Sept., 1904. No. 64806 C.

## ELECTRO-PHYSICS.

**Coherers.**

Coherer Action. Dr. K. E. Guthe. Reviews experimental investigations made and the theories proposed for an explanation of coherer action, and formulates a theory, attempting to show its agreement with phenomena observed. Also bibliography. 4500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65344 D.

**Compressible Atoms.**

The Relation of the Hypothesis of Compressible Atoms to Electrochemistry. Prof. Theodore William Richards. Shows that this hypothesis, dealing as it does with very intimate relations of energy and material, is not without suggestiveness to the electrochemist and electrician. 3500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65320 D.

**Condensation.**

Condensation Nuclei. Prof. C. T. R. Wilson. An explanation and discussion of the theory of condensation of water vapor on ions. 5000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65346 D.

**Conductivity.**

Effect of the Atmosphere on the Conductivity of Aluminium Alloys. Ernest Wilson. Read at the British Assn. An account of experimental investigations. 700 w. Elect'n, Lond—Aug. 26, 1904. No. 64860 A.

Electric Conduction in Metals, from the Standpoint of the Electronic Theory. Prof. P. Drude. A treatment of this subject containing some hitherto unpublished ideas. 4500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65345 D.

The Electrical Conductivity of Gases. Prof. Percival Lewis. Discussion of observed phenomena and of theories, principally ionization. 5400 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65333 D.

**Dielectrics.**

On Electrostriction. Prof. Louis Trenchard More. An account of new experiments, describing the apparatus used, giving results. 4500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65342 D.

**Electric Waves.**

The Unobtained Wave Lengths Between the Longest Thermal and the Shortest Electric Waves Yet Measured. Prof. E. F. Nichols. A brief survey of present knowledge suggesting several experiments directed toward the production and measurement of short electric waves. 1200 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65338 D.

**Fogs.**

Dispelling Fog by Electricity—An Experimental Proof. A. Frederick Collins. An account of the experimental investigations in this field, made by Sir Oliver Lodge. Ills. 2000 w. Sci Am—Sept. 3, 1904. No. 64760.

**Heat Equivalent.**

The Mechanical Equivalent of Heat Measured by Electrical Means. Prof. Howard T. Barnes. Discusses the most probable value of the mechanical equivalent in terms of the generally accepted values of the electric unit. 4000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65336 D.

**Holtz Machine.**

The Priority of Invention of the Double Plate Influence Machine (Zur Priorität der Erfindung der Influenzmaschine mit Doppelter Drehung). Dr. W. Holtz. An account of the development of the static electrical machine, with especial reference to the form employing two plates revolving in opposite directions. 2000 w. Elektrotech Zeitschr—Aug. 18, 1904. No. 65155 B.

**Insulation.**

On Insulation. Discusses some of the conditions which have to be fulfilled by a good insulator, and the tests that should

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be made. 3500 w. Elec Engr, Lond—Sept. 16, 1904. No. 65242 A.

**Ionization.**

The Theory of Ionization by Collision. Prof. J. S. Townsend. Describes this theory in order to explain some of the phenomena which occur in the development of the large currents in a gas. 5800 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65339 D.

**Magnetism.**

Energy Losses in Magnetizing Iron. W. M. Mordey and A. G. Hansard. Read before the British Assn. A report of investigations made and their results. 2500 w. Elec Engr, Lond—Aug. 26, 1904. No. 64863 A.

On Magnetostriction. Prof. H. Nagaoka. A brief survey of the experimental knowledge on this subject, including some new results. 4400 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65343 D.

The Magnetic Effect of Moving Charges. Dr. Harold Pender. Considers the experimental evidence we have in favor of the assumption that an electric charge in motion produces a magnetic field, shows how the evidence has been obtained, and points out a few of the difficulties which have had to be overcome. 5000 w. Int Elect Cong of St. Louis—Sept., 1904. No. 65340 D.

**Radioactivity.**

Concerning Natural Radioactivity of the Atmosphere and the Earth. J. Elster and H. Geitel. A short review of investigations in this field and remarks on the importance of the discoveries. 2000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65278 D.

On the Radioactivity of Mineral Oils and Natural Gases. Prof. J. C. McLennan. Record of experiments, with tables and diagrams. Ills. 6000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65335 D.

The Radioactive Atom (Das Radioaktiv Atom). A. Reuterdahl. A brief examination of the relation of radioactivity to the atomic theory of matter. 2500 w. Elektrochemische Zeitschr—Sept., 1904. No. 65174 G.

**Rectifiers.**

Electrolytic Rectifiers—An Experimental Research. Albert Nodon. An account of a series of researches conducted by the writer at the Sorbonne and the Collège de France. 3500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65279 D.

**Reluctance.**

The Magnetic Reluctance of Air Cores in Short Coils. W. M. Thornton. Gives an account of experiments undertaken to determine the constants for coils of common proportions, the thickness and length of the windings of which placed them beyond ordinary mathematics. 1100 w. Elect'n, Lond—Sept. 16, 1904. No. 65246 A.

**Spectrum Analysis.**

Spectra of Gases at High Temperatures. Prof. John Trowbridge. Gives interesting facts obtained in researches to obtain a new series of hydrogen lines which might manifest themselves at high temperatures. A study of discharges of electricity in rarified gases. 3000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65337 D.

## GENERATING STATIONS.

**Alternating Currents.**

The Computation of Alternating Currents without the Assumption of a Constant Coefficient of Self-Induction (Die Berechnung von Wechselströmen ohne Annahme Konstanter Selbstinduktionskoeffizienten). F. Spielmann. An elaborate mathematical treatment, including variable coefficients for self-induction. 2000 w. Zeitschr f Elektrotechnik—Aug. 14, 1904. No. 65168 D.

**Armatures.**

The Design of Armature Coils. Gives formulas intended for use after the electrical design of the machine has been completed, except the final shaping of the core, so that they may properly overlap. 600 w. Elec Wld & Engr—Sept. 17, 1904. No. 65047.

The Distribution of Magnetic Induction in Multipolar Armatures. W. M. Thornton. Read before the British Assn. A study of the effect of pole spacing, the length of the air-gap, the flux density within it, and the radial depth of the core upon the flux density in the core. Ills. 2200 w. Elect'n, Lond—Aug. 26, 1904. No. 64859 A.

**Compounding.**

Recent Developments in Compounded Alternators with Alternating-Current Self-Excitation. Alexander Heyland. An illustrated explanation of the present construction of the machines. 4000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65271 D.

**Converters.**

Rotary Converters and Motor Generator Sets. William C. L. Eglin. A description and comparison. 2400 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65301 D.

**Day Loads.**

A Day Load as a Factor in Central Sta-

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tion Earning Capacity. Lehman B. Hoit. Read before the Ohio Elec. Lgt. Assn. A brief consideration of some of the essential features of electric power, transmission, and the comparative relations of costs, returns and load factor. 2000 w. Elec Rev, N Y—Sept. 10, 1904. No. 64943.

**Bynamos.**

Management of Dynamos. Directions for properly caring for dynamos, especially the magnet winding, terminals and commutator. 3000 w. Mech Engr—Sept. 3, 1904. No. 64956 A.

The Design of Dynamos. Gives mathematical methods of obtaining dimensions. 900 w. Elec Rev, Lond—Sept. 16, 1904. No. 65244 A.

**Exposition.**

The Electric Generating Plants at the St. Louis Exposition (Die Stromerzeugungsanlage auf der Weltausstellung in St. Louis). Clarence Feldmann. A description of the various generating sets, forming exhibits, and furnishing current for the St. Louis Exposition. 3000 w. Zeitschr d Ver Deutscher Ing—Sept. 10, 1904. No. 65111 D.

The Power Plant of the St. Louis Exhibition. Illustrated detailed description of the plant furnishing electric current for the various lighting and power purposes. 4800 w. Eng News—Sept. 15, 1904. No. 64980.

**Gas-Plants.**

A Gas-Driven Electric Light and Traction Plant. Arthur H. Allen. An illustrated detailed description of the Walthamstow Electricity Works in England. 4500 w. Public Works—Sept. 15, 1904. No. 65034 D.

Gas and Power Engineering Development in Monterey County, Cal. George P. Low. An illustrated account of the upbuilding, growth, development, and engineering features of the Salinas and Monterey properties of the Monterey County Gas and Electric Company of Monterey, California. 10000 w. Jour of Elec—Sept., 1904. No. 65254 C.

**Humming.**

The Humming of Electrical Machines. J. Fischer Hinnen, in the *Zeitschrift für Elektrotechnik*. Describes how absolutely silent running may be secured. 1400 w. Elec Engr, Lond—Sept. 9, 1904. No. 65027 A.

**Hydro-Electric.**

Electricity from Water Power. A. A. Campbell Swinton. Read before the British Assn. A review of what has been accomplished in hydro-electric engineering. 4400 w. Elec Engr, Lond—Aug. 26, 1904. No. 64862 A.

The Dan River Power & Manufacturing Company's Plant. An illustrated account of the construction of a complete manufacturing property, including a cotton factory of 43,000 spindles, at Danville, Va. 3500 w. Eng Rec—Sept. 3 1904. No. 64818.

The Glommen Hydraulic Power Works. Particulars from a detailed account by T. Kinbach, in the *Zeitschrift des Vereines deutscher Ingenieure*. Illustrates and describes a plant for the distribution of electrical energy for power and other uses in Christiania, and neighboring towns in Norway. 2500 w. Engr, Lond—Aug 26, 1904. No. 64870 A.

The Guanajuato Hydro-Electric Transmission. Robert McF. Doble. Read before the Pacific Coast Elec. Trans. Assn. Illustrated detailed description of a notable hydro-electric development and high potential long-distance transmission, recently completed in Mexico. 7500 w. Jour of Elec—Sept., 1904. No. 65253 C.

The Hydro-Electric Station at Bogota. A. Steens. Illustrated description of an interesting station, 8,300 ft. above the sea level. 1600 w. Eng Rec—Sept. 3, 1904. No. 64817.

The Northern California Power Company's Systems. An illustrated detailed description of the Volta hydro-electric plant of this company. 3500 w. Elec Wld & Engr—Sept. 10, 1904. Serial. 1st part. No. 64947.

The Puget Sound Power Company. Describes the interesting features of these works in the State of Washington, U. S. A., to furnish power for Seattle and Tacoma. 2500 w. Engr, Lond—Sept. 2, 1904. Serial. 1st part. No. 64963 A.

The Rauris-Lend Electric Power Station (Die Elektrische Kraftübertragung Rauris Lend). H. Spyri. Describing the electric plant of the Austrian branch of the Neuhausen Aluminum Company, near Gastein, in the Tyrol. Two articles. 2500 w. Schweiz Bauzeitung—Aug. 6, 20, 1904. No. 65183 each B.

The Waipori Falls Electric Power Company's Project. Illustrations with description of the manner of carrying out this project of supplying electric current hydraulically developed in New Zealand. 1800 w. N Z Mines Rec—June 16, 1904. No. 64952 B.

Types of Large Water-Power Installations. Dr. F. A. C. Perrine. An interesting review of the development of the transmission and distribution of the power of water-falls, the effect on industry, describing typical plants. 3300 w. Cent Sta—Sept., 1904. No. 64924.

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**Isolated Plant.**

The Daniels & Fisher Power Plant in Denver. Howard S. Knowlton. Illustrates and describes the isolated plant of a large department house. 3000 w. Eng Rec—Sept. 3, 1904. No. 64819.

The Mechanical and Electrical Equipment of the Hotel Astor. Illustrated detailed description. 1800 w. Elec Rev, N Y—Sept. 17, 1904. No. 65012.

**Location.**

Location of Electric Stations. Alton D. Adams. Reviews the practice of early plants and the movement later toward cheap land with free condensing water and direct boat or rail transportation. 3700 w. Elec Wld & Engr—Sept. 3, 1904. No. 64833.

**Regulation.**

Calculation of Alternator Regulation. C. E. Canfield. Describes methods for calculating the value of the armature reaction and inductive reactance and for treating the quantities when so found. Also editorial. 4000 w. Elec Wld & Engr—Sept. 3, 1904. No. 64832.

The Regulation of Alternators. D. B. Rushmore. A summary of work done and methods used for determining regulation, and the results of tests on differing types of machines. Ills. 3500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65277 D.

**Station.**

The Broad Street Station of the Citizens' Light, Heat & Power Company, Johnstown, Pa. Illustrated detailed description of this station and its equipment. 2000 w. Power—Sept., 1904. No. 64754 C.

**Switchboards.**

The Traffic Design of Central Office Switchboards. A. Dallam O'Brien. Discusses the features that must be carefully considered in providing for the requirements of a proposed installation from a traffic standpoint. 3000 w. Am Elect'n —Sept., 1904. No. 64846.

**Tariffs.**

Rates for Electricity Supply. Etienne de Fodor. A discussion of the conditions which led to the present rates, reviewing the history of electrical current tariff, and considering the advantages to be derived from a unit price. 5000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65305 D.

The Tariff Question in Electric Stations (Zur Tariffrage der Elektricitätswerke). Fritz Hoppe. Discussing the best methods of charging for electric current supply, considering the side both of the producer and the consumer. 7000 w. Elektrotech Zeitschr—Aug. 25, 1904. No. 65156 B.

**Transformers.**

Transformer Testing for Central Stations. S. E. Johanneson. Read before the Ohio Elec. Lgt. Assn. Describes the methods of making the various tests which may be applied to transformers. 4700 w. Elec Rev, N Y—Sept. 17, 1904. Serial. 1st part. No. 65013.

**Turbo-Generators.**

A Turbo-Electric Plant in a Paint Works. Illustrated description of a Cleveland plant for a large paint and varnish manufactory. 2500 w. Engr, U S A—Sept. 1, 1904. No. 64822 C.

Effect of the Steam Turbine on Central Station Practice. W. L. R. Emmet. A discussion of the advantages claimed for the steam turbine, the conditions that lead to their adoption, and the points of greatest importance. 3800 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65299 D.

Steam Turbine Generators. B. A. Behrend. Discusses the mechanical requirements and principles of their design. Ills. 2000 w. Elec Rev, N Y—Sept. 10, 1, 1904. No. 64822 C.

Turbo-Generators Exhibited at the World's Fair. Illustrates and describes the exhibits of the Westinghouse, General Electric, and De Laval companies. 3000 w. Elec Rev, N Y—Sept. 10, 1904. No. 64944.

## LIGHTING.

**Arc Lamps.**

Points for Consideration When Purchasing Alternating-Current Arc Lamps. G. Brewer Griffin. Abstract of a paper read before the Ohio Elec Lgt Assn. Discusses the construction and performance, the effect upon the eye, etc. 4000 w. Elec Rev, N Y—Sept. 3, 1904. No. 64827.

Raising and Lowering Gear for Arc Lamps. Donald Smeaton Munro. States the points of a good gear, and describes an appliance which seems to meet the requirements. Ills. 1700 w. Elec Rev, Lond—Sept. 16, 1904. No. 65243A.

**Arcs.**

The Electric Arc. Prof. C. D. Child. An attempt to make plain the principles on which an explanation of the electric arc must be based, to consider the different views which are possible, show what facts can be explained and what questions must yet be answered. 2800 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65341 D.

**Automatic Lighting.**

An Automatic Lamp Lighting and Extinguishing Device. Dr. Alfred Graden-

witz. Illustrates and describes a device for automatically lighting and extinguishing lamps of any kind. Invention of Mr. E. Ruhmer. 800 w. Sci Am Sup—Sept. 24, 1904. No. 65085.

**Filaments.**

Treating Incandescent Lamp Filaments. Ralph McNeill. An outline of the "treating" or "flashing" of the filament. Ills. 1500 w. Elec Wld & Engr—Sept. 3, 1904. No. 64830.

## MEASUREMENT.

**Curves.**

Causes for the Deformation of the Pressure Curves in Alternators (Die Ursachen der Deformationen von Spannungskurven in Wechselstrommaschinen). P. Wangemann. A study of the deviation of the pressure curves from the theoretical sine form, showing the influence of the arrangement of poles, and of the construction of the machine. Two articles. 7500 w. Elektrotech Zeitschr—Sept. 8, 15, 1904. No. 65161 each B.

**Dynamo Losses.**

The Division of Losses in Continuous-Current Dynamos (Beitrag zur Trennung der Effecktverluste in Gleichstrommaschinen). E. Cramer. Deriving equations and curves for the separation of the hysteresis and eddy-current losses. 1200 w. Elektrotech Zeitschr—Aug. 8, 1904. No. 65154 B.

**Dynamometer.**

The Electrodynamometer (Ueber Elektrodynamometer). Dr. Th. Bruger. Describing a convenient instrument for the direct indication of the energy developed by an alternating current. 3000 w. Elektrotech Zeitschr—Sept. 15, 1904. No. 65167 B.

**Laboratory.**

The Equipment of a Commercial Testing Laboratory. Dr. Clayton H. Sharp. An outline of the equipment needed for the various kinds of work to be done, and the conditions that must be kept in view. 6000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65274 D.

**Meters.**

American Meter Practice. George Ross Green. Information concerning meter practice in America, compiled from letters received from a large number of electric lighting companies. Ills. 14400 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65302 D.

A Standard for Quick Meter Calibration. George T. Hanchett. Suggests a method which, although rather expensive in first cost is justified when there are many rotary standards to be calibrated daily. 1000 w. Cent Sta—Sept., 1904. No. 64923.

A Study of Integrating Electric Meters. Caryl Davis Haskins. A record of such starting points as have up to the present time been shown to be worthy of development into an integrating meter. 5000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65306 D.

**Photometry.**

On Large Bulb Incandescent Lamps as Secondary Standards of Light. J. A. Fleming. Abstract of a paper read before the British Assn. Gives points of importance in the construction of these lamps, and precautions to be taken in their use with information of interest. 2000 w. Elect'n, Lond—Aug. 26, 1904. No. 64858 A.

Photometric Experiments with Selenium. FitzHugh Townsend. Describes the use of selenium as a means for measuring light. Also editorial. 3300 w. Elec Rev, N Y—Sept. 10, 1904. No. 64945.

Standards of Light. Prof. Edward L. Nichols. Discussion of various standards, principally the amyl-acetate flame and the acetylene flame, with tables and curves. 5000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65334 D.

**Reichsanstalt.**

The Work of the Physical-Technical Reichsanstalt for 1903 (Die Tätigkeit der Physikalisch-Technisch Reichsanstalt im Jahre 1903). An abstract of that portion of the report for 1903 relating to the testing and calibrating of electrical apparatus and other electrical work. 4500 w. Elektrotech Zeitschr—Sept. 8, 1904. No. 56164 B.

**Standards.**

Experiments for Improving the Construction of Practical Standards for Electrical Measurements. Abstract of the report of a committee of the British Assn. 2500 w. Elect'n, Lond—Sept. 9, 1904. No. 65031A.

**Testing.**

The Testing of Alternating Current Generators. B. A. Behrend. Describes an improved method devised by the author for testing alternating-current generators and synchronous motors, under full-load conditions, without actually having to place the machines under full load. Ills. 1300 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65297 D.

**Units.**

The So-called International Electrical Units. Dr. Frank A. Wolff. Historical review and discussion of units and standard cells. 9500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65332 D.

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**Voltameters.**

The Lead Voltameter. Anson G. Betts and Dr. Edward F. Kern. Gives a short account of the silver voltameter, and the results obtained by comparing the lead voltameter. 2500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65325 D.

The Silver Voltameter. Dr. K. E. Guthe. Gives rules adopted in the United States where the silver voltameter has been legalized, and discusses sources of trouble that may arise, etc. 3500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65326 D.

## MOTORS.

**Alternating Current.**

Alternating-Current Motors. Charles Proteus Steinmetz. Gives a general theory of the alternating-current motor, applicable alike to the induction and commutator motors to enable a critical judgment of their advantages and disadvantages. 11000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65270 D.

**Diagrams.**

The Circle Diagram for Speeds Above Synchronism (Das Kreisdiagram für Ueber Synchronismus). Dr. Gustav Benischke. A review of the contention of Müller as to the inapplicability of the circle diagram to induction motors at speeds above synchronism, showing that by a modified construction the diagram may be successfully applied. 1800 w. Elektrotech Zeitschr—Aug. 25, 1904. No. 65157 B.

**Induction Motors.**

A Method of Designing Induction Motors. H. M. Hobart. An investigation limited to three-phase squirrel-cage induction motors. 1600 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65318 D.

The Hopkinson Test as Applied to Induction Motors. W. E. Sumpner and R. W. Weekes. Gives experimental details of a test made of a number of induction motors, by this method. 2000 w. Elec Engr, Lond—Aug. 26, 1904. No. 64865 A.

The Reluctance of the Air-Gap in the Induction Motor. N. Pensabene. Considers the case of semi-enclosed slots in stator and closed slots in rotor, and also the case where both stator and rotor have semi-enclosed slots. 700 w. Elec Engr, Lond—Aug. 26, 1904. No. 64864 A.

**Parallel Operation.**

Some Practical Experiences in the Operation of Many Power Plants in Parallel. R. F. Hayward. A review of the lessons learned from the long-distance transmission plants operating in parallel, and supplying power over large areas of territory. 6300 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65311 D.

**Repulsion Motors.**

The Repulsion Motor. A. S. M'Allister. An explanation of its inherent characteristics, calculation of performance, etc. 2500 w. Am Elect'n—Sept., 1904. No. 64844.

**Single Phase.**

Improved Commutator-Motors for Single-Phase Alternating Currents (Neue Kollektormotoren für Einphasigen Wechselstrom). Clarence Feldmann. An examination of the action of the commutator as used on single-phase alternating motors. Two articles. 5000 w. Zeitschr d Ver Deutscher Ing—Aug. 20, Sept. 10, 1904. No. 65106 each D.

Single-Phase Motors. Max Deri. A review of the essential functions and relations of modern single-phase motors in order to facilitate a comparison of the working conditions and commutating requirements of the different systems. 6000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65300 D.

## TRANSMISSION.

**Cables.**

Insulating Materials in High-Tension Cables. E. Jona. Discusses the various materials used, their enduring qualities, tests made, etc. 6000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65303 D.

The Insulation of Cables (Ueber Kabelisolation.) J. Schmidt. Discussing the materials employed for the insulation of cables carrying high voltage currents. 2000 w. Zeitschr f Elektrotechnik—Sept. 11, 1904. No. 65172 D.

**Conductors.**

Conductors for Long Spans. Francis O. Blackwell. Gives results of investigations made to determine the characteristics of conductors so as to secure some definite basis upon which to figure long spans. 2800 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65314 D.

**France.**

Electric Transmission in France. Daniel Bellet. Illustrates and describes an installation designed to distribute power and light throughout the Aude, in the Pyrenean district, by high tension mains branched off from a central distributing station located 43.5 miles from the power house. 2800 w. Trac & Trans—Sept., 1904. No. 64960 E.

**High Tension.**

American Practice in High-Tension Line Construction and Operation. Dr. F. A. C. Perrine. A review of what is considered the best practice. 5500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65316 D.

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Report of Committee on High-Tension Transmission. Presents in a condensed form, answers to a set of questions sent out. Also discussion on the report. Ills. 19000 w. Trans Am Inst of Elec Engrs—Sept., 1904. No. 65099 D.

Report on High Voltage Transmission Lines. Report to the Utica convention of the committee appointed to investigate the dangers incident to high voltage power transmission lines. 1800 w. St Ry Jour—Sept. 24, 1904. No. 65217 C.

Some Difficulties in High-Tension Transmission and Methods Mitigating Them. J. F. Kelly and A. C. Bunker. Discussing the conditions which affect and limit the constants and operation of high-tension lines, considering only pressures of over 30,000 volts and lines of over 50 miles in length. 5000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65309 D.

The Construction and Insulation of High-Tension Transmission Lines. M. H. Gerry, Jr. Discusses the problems connected with this work. The methods are drawn entirely from American practice. Ill. 4500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65317 D.

The Twickenham and Teddington Electricity Undertaking. Max J. E. Tilney. An illustrated outline of a high-tension scheme now in progress. 2300 w. Elect'n, Lond—Sept. 16, 1904. No. 65245 A.

**Insulation.**

Some Elements in the Design of High-Pressure Insulation. Prof. Harris J. Ryan. Presents the elements of modern electrical science upon which must rest the trained judgment of the designer of high-pressure insulation, with tests and measurements. 4500 w. Int Elec Cong of St Louis—Sept., 1904. No. 65272 D.

**Long Distance.**

High Potential, Long Distance Transmission and Control. F. G. Baum. Gives the practice and results on the greatest transmission system in existence—the California Gas and Electric Corporation. 5000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65313 D.

The Bay Counties Power Co.'s Transmission System. L. M. Hancock. Gives an outline of the general and controlling features, dealing more at length with the organization of the forces to operate the plant and to carry on construction and repairs of a long distance plant in California. 5500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65312 D.

**Power Development.**

Rock Creek, Oregon, Power and Transmission System. An illustrated description of an interesting power development in a thinly populated district of the West. 2000 w. Elec Wld & Engr—Sept. 3, 1904. No. 64829.

## MISCELLANY.

**Contractors.**

The Status of the Electric Contractor. A. H. Scott. Reviews the history of the organization and growth of the National Electrical Contractors' Association of the United States. 2500 w. Elec Wld & Engr—Sept. 10, 1904. No. 64948.

**Exposition.**

Some of the Electrical Features of the Exposition. E. B. Ellicott. Calls attention to some points of interest in the electrical work. Ills. 2500 w. Jour W Soc of Engrs—Aug., 1904. No. 65096 D.

**Inspection.**

The Growing Duties and Responsibilities of the Municipal Electrician. Capt. William Brophy. An account of the work performed formerly by insurance inspectors, and now being assumed by municipal authorities, discussing its evils. 2000 w. Elec Wld & Engr—Sept. 10, 1904. No. 64949.

The Inspection and Insurance of Electrical Machinery. From the report of Mr. Michael Longridge, giving interesting records of the experience of his company in connection with the working and breakdown of electrical machinery. 6500 w. Mech Engr—Sept. 10, 1904. No. 65026 A.

# INDUSTRIAL ECONOMY

**Accounts.**

Foundry Casting Accounts. J. Davidson. Gives forms used, with explanatory remarks. 700 w. Foundry—Sept., 1904. No. 65072.

**Apprentices.**

The Foundry Apprentice as Seen in One Shop. Charles H. Thomas. Read before the A. F. A. Convention. Discusses the question of apprenticeship in the foundry, and suggests ways of interesting and helping the boys. 1200 w. Foundry—Sept., 1904. No. 65068.

**Cost Keeping.**

Gathering Engineering Cost Data. Halbert P. Gillette. Abstracted from a lecture before the civil and mining engineering students of Columbia University.

*We supply copies of these articles. See page 319.*

Suggestions on the methods of securing and using cost data. 4000 w. Sch of Mines Qr—July, 1904. No. 65058 D.

**Education.**

The Education of a Technical Chemist. Sir William Ramsay. Address before the Society of Chemical Industry. Suggestions of value. 5000 w. Sci Am Sup—Sept. 17, 1904. No. 64987.

The Outlook for Engineering Education. C. Frank Allen. Extracts from the presidential address before the Society for the Promotion of Engineering Education. Discusses the fields open to men trained as engineers, and the preparation best suited to meet the requirements. 3500 w. Eng News—Sept. 15, 1904. No. 64981.

**Exposition.**

The International Exposition at St. Louis (Die Weltausstellung in St. Louis). Fr. Frölich. An excellent and fully illustrated description of the technical and engineering features of the exposition by the special representative of the Verein Deutscher Ingenieure. Three articles. 18000 w. Zeitschr d Ver Deutscher Ing—Aug. 27, Sept. 3, 10, 1904. No. 65107 each D.

The St. Louis Exposition from the Standpoint of the Engineer. W. H. Bryan. A handsomely illustrated account of the exposition, treating of the salient points of the project, its execution, and the exhibits of mechanical interest. 5000 w. Engineering Magazine—October, 1904. No. 65191B.

**Iron Industry.**

The Census of the Iron Ore Industry. A review of the special report for the Twelfth Census, prepared by John Berkinbine, showing the phenomenal growth 6400 w. Ir Age—Sept. 15, 1904. No. 64971.

**Labor.**

The Labor Problem. F. J. Symmes. Read before the Pacific Coast Gas Assn. A discussion of the labor unions and their attitude and what has been accomplished in overcoming difficulties. General discussion. 6000 w. Pro Age—Sept. 15, 1904. No. 64978.

**Patents.**

Compulsory Working of Patented Inventions—A British View. W. Craig Henderson. Discusses the question whether patentees ought to be compelled, on penalty of forfeiture, to work their inventions in the country where a patent has been obtained. The view is adverse to compulsory working. 2800 w. Elec Wld & Engr—Sept. 3, 1904. No. 64831.

**Piece Work.**

Piece Work. Le Grand Parish. With particular reference to the card department. 3000 w. Am Engr & R R Jour—Sept., 1904. No. 64788 C.

**Premium System.**

The Premium System in England and the United States (Le Système des Primes en Angleterre et aux Etats Unis). Jean Bosler. A review of the various modifications of the premium system for remunerating labor, showing their relation to modern intensified production. 4000 w. Revue de Mécanique—Aug. 31, 1904. No. 65135 E + F.

**Shop Records.**

A Work in Progress Record. H. B. McCabe. Describes a shop system for use where large quantities of the same article are made. 2200 w. Am Mach—Sept. 22, 1904. No. 65076.

**State Control.**

The Plan for the State Control of the Hibernia Coal Mines (Die Geplante Verstaatlichung der Bergwerks-Gesellschaft Hibernia). H. Engel. An account of the plans of the Prussian Government to obtain a controlling influence in the coal syndicate. 3000 w. Glückauf—Aug. 13, 1904. No. 65142 D.

**Subsidies.**

French Shipping Subsidies. A review of the laws dealing with navigation subsidies in France, discussing the results. 2500 w. Trac & Trans—Sept., 1904. No. 64967 E.

Subsidies with Relation to American Shipping. Briefly reviews the steps taken by other countries to increase the mercantile marine, and the effect. Also considers the best means for America to adopt. 2500 w. Marine Engng—Sept., 1904. No. 64782 C.

**Technology.**

The Influence of the Technical Department Upon the Workshop (Der Einfluss des Technischen Bureaus auf die Fabrikation). F. A. Neuhaus. A discussion of the great commercial value of a scientific technical department to the manufacturer. 4000 w. Zeitschr d Ver Deutscher Ing—Aug. 13, 1904. No. 65102 D.

**Wages.**

Discomfort vs. Skill as a Wage Basis. Thomas D. West. An argument against the position that a chief consideration in fixing wages should be the prosecution of the work under comfortable conditions. 2000 w. Ir Trd Rev—Sept. 8, 1904. No. 64875.

See also Mining & Metallurgy, Railway Engineering, and Street & Electric Railways.

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# MARINE AND NAVAL ENGINEERING

**Battleship.**

Machinery of the Italian Battleship Regina Margherita. Describes the machinery of an Italian warship which has just satisfactorily completed her official contract steam trials. Ills. 2000 w. Marine Rev—Sept. 15, 1904. No. 65008.

**Boilers.**

See Mechanical Engineering, Steam Engineering.

**Ferryboats.**

American Ferryboats. Illustrations and brief review of main types in use, with list of the screw and paddle ferryboats of the United States. 2500 w. Naut Gaz—Sept. 1, 1904. No. 64823.

The New Staten Island Ferryboats. An illustrated description of these boats which will be the finest vessels of their class in the world. 4000 w. Naut Gaz—Sept. 1, 1904. No. 64824.

The New Ferryboats for the New York-Staten Island Service. Illustrated description with specifications. 1500 w. Marine Engng—Sept., 1904. Serial. 1st part. No. 64781 C.

**Fireboat.**

Pacific Coast Fire-Boat. Illustrated description of a boat recently built for the city of Portland in Oregan. 900 w. Naut Gaz—Sept. 22, 1904. No. 65097.

**Freight Steamer.**

New Twin-Screw Freight Steamer Boston of the Fall River Line. Illustration, with brief description. 1200 w. Marine Engng—Sept., 1904. No. 64780 C.

**Liquid Fuel.**

A Comprehensive Extract from the Report of the "Hohenstein Boiler" and "Liquid Fuel" Boards. Gives such portions of the report as are of most general interest. Ills. 5000 w. Jour Am Soc of Nav Engrs—Aug., 1904. No. 65203 H.

**Motor Boats.**

Problem of the Auto Boat. William F. Durand. Discusses elements of successful hull design in the present number. 1800 w. Automibile—Sept. 3, 1904. Serial. 1st part. No. 64801.

**Propeller-Blades.**

Propeller-Blade Inaccuracies: Proposed Method of Machining and Finishing. W. Strother Smith. An official report to the Bureau of Steam Engineering. Describes a method of securing accurate finish of the driving face of a propeller-blade to the true designed pitch by means of a machine. 1200 w. Jour Am Soc of Nav Engrs—Aug., 1904. No. 65205 H.

**Ship.**

The Five-Masted Ship Preussen (Das Fünfmast - Vollschiff Preussen). W. Kaemmerer. Details of construction of full-rigged ship of five masts of 11,150 tons displacement. Steam steering and hoisting gear are used. 2500 w. 1 plate. Zeitschr d Ver Deutscher Ing—Aug. 20, 1904. No. 65105 D.

**Shipments.**

Mineral Shipments at British Ports. Brysson Cunningham. An illustrated review of the various systems in vogue for the shipment of minerals, such as coal and ore. 3000 w. Cassier's Mag—Aug., 1904. No. 65004 B.

**Steamers.**

The Austrian Lloyd's Steamer "Africa." Illustrated description of a recently built twin-screw steamer for the East African line. 1000 w. Engng—Sept. 2, 1904. Serial. 1st part. No. 64960 A.

The "Minnesota," the Largest Steamship Ever Built in America. Illustrated description of a large vessel built for the Pacific trade. 1000 w. Sci Am—Sept. 3, 1904. No. 64759.

**Submarines.**

Submarine Navigation (La Navigation Sous-Marine). H. Noalhat. A review of the problems which are involved in the attainment of successful submarine navigation. Serial. Part I. 3000 w. Revue Technique—Aug. 10, 1904. No. 65126 D.

**Troopship.**

The Indian Troopship "Dufferin." Gives information of the progress made in this class of vessels, describing the "Dufferin," recently launched. 1500 w. Engng—Sept. 16, 1904. No. 65248 A.

**Tugs.**

Italian Sea-going Salvage Tug Sars. Illustrations, with brief description. 700 w. Marine Engng—Sept., 1904. No. 64783 C.

**Turbine Steamers.**

The New Cunard Turbine Steamers. Illustrates and describes the exhibits of the Cunard Steamship Company at St. Louis, giving information of the most notable features of the turbine steamers. 1000 w. Sci Am—Sept. 10, 1904. No. 64919.

**United States Navy.**

The Naval Strength of the United

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States. George W. Melville. Considers some of the factors that have been given too little consideration in the past in estimating the relative strength of navies, and related matters of interest. 8400 w. Jour Fr Inst—Sept., 1904. No. 65064 D.

**Unloading.**

New Grain Elevators at Leith Docks. Describes elevators in Scotland for the rapid discharging of grain ships. 1300 w. Engr, Lond—Sept. 9, 1904. No. 65043 A.

# MECHANICAL ENGINEERING

## AUTOMOBILES.

**Belt Transmission.**

Flexible Power Transmission for Motor Vehicles. Sidney Russell. An illustrated review of belt-driven motor vehicles is given in this article. 6000 w. Trac & Trans—Sept., 1904. No. 64968 E.

**Diagram.**

Power Diagram for Motor Vehicles. P. S. Bushnell. Gives diagram for solving problems in motor vehicle design, involving the relation of the speed of the vehicle to the traction, the percentage of gradient and power required under various conditions. 400 w. Am Mach—Vol. 27, No. 36. No. 64888.

**Ignition.**

High Tension Magneto-Ignition. Illustrated descriptions of the construction of the best known forms of this apparatus, the Eisemann, the Simms-Bosch and the Bassie-Michel. Also discusses the ignition question in general. 1300 w. Auto Jour—Sept. 3, 1904. Serial. 1st part. No. 64955 A.

**Omnibus.**

A Forty-Passenger Automobile. Illustrated detailed description of a sightseeing automobile with terraced seats. 1200 w. Ir Age—Sept. 22, 1904. No. 65074.

The Clarkson Steam Motor Omnibus. Illustrated detailed description of an English vehicle. 1300 w. Engng—Sept. 16, 1904. No. 65249 A.

**Petrol Cars.**

The "Dixi" Petrol Cars. Illustrates and describes these cars, particularly those having a tubular chassis construction. 1000 w. Auto Jour—Sept. 17, 1904. Serial. 1st part. No. 65237 A.

The 1904 Panhard-Levassor Petrol Cars. An illustrated detailed description of the 1904 models, particularly the 4-cylinder 10-h. p. and the 3-cylinder 8-h. p. types. 2200 w. Auto Jour—Aug. 27, 1904. Serial. 1st part. No. 64854 A.

**Rover.**

The New 8-H. P. Rover Car. Illustrates and describes this car, which is one of the new machines entered in the small car trials. Its striking features are the central box girder in place of the usual frame, the engine brake and disc clutch. 1800 w. Autocar—Aug. 27, 1904. No. 64853 A.

**Side-Slip.**

Side-Slip in Motor Cars. Horace Darwin and C. V. Barton. An explanation of one of the causes of skidding of wheels on motor cars when on slippery roads. 3000 w. Autocar—Sept. 10, 1904. No. 65024 A.

**Touring Car.**

Welch Gasoline Touring Car. Illustrates and describes this year's design, noting the improved features. 800 w. Automobile—Sept. 10, 1904. No. 64933.

**Trials.**

Small Car Reliability Trials at Hereford. An illustrated account of trials of cars costing £200 or less. Also details of the cars entered. 7700 w. Autocar—Sept. 3, 1904. Serial. 1st part. No. 64954 A.

## HEATING AND COOLING.

**Air Flow.**

The Measurement of Air Flow (Ueber die Messung von Luftschwindigkeiten). Dr. A. Marx. An exhaustive study of the measurement of the velocity of the flow of air in ventilating passages and conduits, discussing anemometers, pressure gauges and other instruments. Serial. Part I. 4500 w. Gesundheits Ingenieur—Aug. 20, 1904. No. 65181 B.

**Central Plant.**

The Central Heating and Ventilating Plant of the Leipzig City Hall (Die Zentral heizungs und Lüftungsanlage im Rathausneubau zu Leipzig). Ludwig Dietz. With plans of the building showing arrangement of the direct and indirect heating, steam plant, etc. 5000 w. 4 plates. Gesundheits-Ingenieur—Sept. 10, 1904. No. 65182 B.

**Exhaust Steam.**

Performance of a Plant with Heating from the Exhaust of Condensing Steam Turbines. Illustrates and describes a very interesting plant installed in the Wing Building, New York City. This is a seven-story structure devoted to manu-

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facturing. 2800 w. Eng Rec—Sept. 3, 1904. No. 64812.

**Fans.**

Centrifugal Fans and Their Application to the Heating of Industrial Buildings. R. B. Hayward. A study of the application to the heating and ventilating of industrial buildings. General discussion. 11000 w. Pro Engrs' Soc of W. Penn—June, 1904. No. 65051 D.

**Refrigeration.**

Refrigerating Plants at Louisiana Purchase Exposition. An illustrated detailed description of this very interesting exhibit. 8500 w. Ice & Refrig—Sept., 1904. No. 64808 C.

## HYDRAULICS.

**Flow.**

A Diagram for the Flow of Water in Pipes. Ernest W. Schoder. Gives diagram and explanation of its use in solving problems in pipe hydraulics. 1300 w. Eng Rec—Sept. 3, 1904. No. 64813.

Diagram Giving Discharge of Pipes by Kutter's Formula. John H. Gregory. Claims to be the originator of the diagram published by Prof. I. P. Church and calls attention to other diagrams which have been published, which are plotted in a similar manner. 1600 w. Eng Rec—Sept. 17, 1904. No. 65020.

See also Civil Engineering, Waterways.

**Pumping.**

A Molasses Pumping Plant in Boston. An account of the plant designed for discharging molasses from tank steamers into tanks in the storehouses. Ills. 3000 w. Eng Rec—Sept. 17, 1904. No. 65016.

The Application of Electric Power to the Drainage of Marshes in the Netherlands (Entwässerung von Marschländereien durch Elektrische Kraftübertragung in den Niederlanden). A description of the use of electric motors and centrifugal pumps for draining polders in the vicinity of Geertruidenberg. 2500 w. Glasers Annalen—Sept. 15, 1904. No. 65149 D.

The Latest Development of Pumping Systems (Die Neueste Entwicklung der Wasserhaltung Sowie Versuche mit Verschiedenen Pumpensystemen). H. Baum. An exhaustive review of the present status of mine pumping, with illustrations of the various machines and systems. Serial. Part I. 3000 w. Glückauf—Aug. 20, 1904. No. 65143 D.

See Mining and Metallurgy, Mining.

**Regulator.**

Automatic Regulator for Pumps (Pompe à Régulateurs Automatiques de Debit). A description of the Daubron system, especially adapted for maintaining a supply to filters under constant pressure. 600 w. Génie Civil—Sept. 10, 1904. No. 65122 D.

**Siphons.**

Siphons: Their Action and Uses in Plumbers' Work. J. Wright Clarke. An illustrated explanation of siphon action and its limit in plumbing work. 2500 w. Plumb & Dec—Sept. 1, 1904. Serial. 1st part. No. 64950 A.

**Water Motor.**

A Home-Made Water Motor of One-Quarter Horse Power. H. F. Swartz. Illustrates and describes an impulse wheel which developed 0.28 brake h. p. and 1000 revolutions on a pressure of 50 pounds. 800 w. Sci Am Sup—Aug. 20, 1904. No. 64742.

**Water-Power.**

Developing a Water-Power. Thorburn Reid. Discusses the elements of financial and commercial success in such undertakings. 3800 w. Cassier's Mag—Aug., 1904. No. 65006 B.

## INTERNAL-COMBUSTION MOTORS.

**Alcohol.**

International Exposition of Alcohol (L'Exposition Internationale des Alcools). G. Coupan. An illustrated account of the exposition recently held at Vienna, including the trials of automobiles using alcohol as fuel. 3000 w. Génie Civil—Aug. 27, 1904. No. 65117 D.

**Carburetters.**

Carburetters for Alcohol Motors (Carburateurs pour Moteurs à Alcool). Réné Dhommée. Discussing the conditions involved in the production of a suitable vaporized charge from alcohol and air, with illustrations of a number of special carburetters for use with alcohol motors. 1200 w. Revue Technique—Aug. 10, 1904. No. 65127 D.

**Diesel.**

Trial of a 240-H. P. Diesel Oil Engine. Michael Longridge. An account of the trials made at the maker's works in Ghent, showing 42 per cent. efficiency. 2500 w. Mech Engr—Sept. 17, 1904. No. 65239 A.

**Efficiency.**

The Economics of Power Engines. Bernhard A. Sinn. Deals principally with explosive engines, but also considers steam engine efficiency and describes the marine gas suction generator. 2500 w. Marine Engng—Sept., 1904. No. 64784 C.

**Exhaust Gases.**

The Calorimetry of the Gases Exhausted from an Internal Combustion Engine. B. Hopkinson. Abstract of a paper

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before the British Assn. Describes tests in which the exhaust gases were passed through a calorimeter and so cooled to near atmospheric temperature, the heat rejected by then being measured. Ills. 2500 w. Engng—Aug. 26, 1904. No. 64869 A.

**Flame Temperatures.**

Flame Temperatures in Internal Combustion Motors. Dugald Clerk. Read before the British Assn. A study of the possibility of reducing flame temperatures by artificial enhanced atmospheric pressures. 1800 w. Elect'n, Lond—Aug. 26, 1904. Serial. 1st part. No. 64861 A.

**Gas Producers.**

Gas Producers for Power. Julius I. Wile. An illustrated article dealing with the several types of producers and their applications and advantages. 4000 w. Power—Sept., 1904. No. 64748 C.

Suction Gas Producer for Use with Explosive Motors Employing Low-Grade Gas Produced Direct from Coal. Illustrates and describes a gas generating installation of the Pierson system. 1500 w. Sci Am Sup—Sept. 3, 1904. No. 64762.

**Gas Turbine.**

The Efficiency of the Gas Turbine (La Turbine à Gaz—Son Rendement). Alfred Barbezat. Describing the Armengaud and Lemâle gas turbine, with computations of efficiency for various ranges of temperature. 2500 w. Schweiz Bauzeitung—Aug. 27, 1904. No. 65177 B.

**Inertia.**

Inertia in Gas and Steam Engines. A. T. Kasley. Explains the meaning of inertia and considers some problems. General discussion. 3000 w. Pro Engrs' Soc of W. Penn—July, 1904. No. 65053 D.

**Testing.**

Tests of an Oil Engine with Steam Injection. Gives an abstract of the results obtained by Messrs. Charles Wineburgh and S. J. Goldwater in testing for oil consumption, a 15-h. p. engine of unusual type placed on the market by Mietz & Weiss, of New York. 4200 w. Eng News —Sept. 15, 1904. No. 64982.

## MACHINE WORKS AND FOUNDRIES.

**Automatic Machines.**

Automatic Screw Machines and Attachments. Engravings, with descriptive notes. 2200 w. Am Mach—Vol. 27. No. 36. No. 64889.

The New Hartford Automatic Screw and Forming Machines. Illustrated description of the machine and its operation. 2200 w. Ir Age—Sept. 8, 1904. No. 64876.

**Castings.**

Molding and Casting of a Gas Engine Cylinder, with Special Treatment of the Casting After Pouring. R. H. Palmer. Illustrated description of the methods used. 1800 w. Am Mach—Vol. 27. No. 37. No. 64973.

Molding a Slag Vessel. Robert Jones. Illustrates and describes method employed. 600 w. Am Mach—Vol. 27. No. 38. No. 65075.

Molding in Cores. H. J. McCaslin. Illustrates and describes methods of making a variety of castings. 1700 w. Foundry—Sept., 1904. No. 65069.

Warping of Castings. Thomas Mack. Illustrates and describes a warped casting and the means adopted for remedying the trouble, discussing the cause. 1000 w. Foundry—Sept., 1904. No. 65066.

**Charts.**

Charts in Designing. John S. Myers. Explains the applicability of record charts and of calculating charts. 2800 w. Mach. N. Y.—Sept., 1904. No. 64770 C.

**Cores.**

Mechanically Made Cores. George H. Wadsworth. Read before the Found. Assn. Describes the three methods of producing cores by mechanical means, illustrating Wadworth's core-making machine. 2000 w. Ir Trd Rev—Sept. 15, 1904. No. 64991.

**Cupolas.**

Blowing Small Cupolas from Stand Pipes. Walter J. May. Directions, with illustrations. 1100 w. Prac Engr—Aug. 26, 1904. No. 64855 A.

**Dust Chamber.**

Dust Chamber Design. Max J. Welch. Illustrations, with descriptions of types of dust chamber construction for collecting flue dust and condensing fumes. 1200 w. Eng & Min Jour—Sept. 1, 1904. No. 64768.

**Electric Driving.**

Electric Motors in Machine Shop Service. Charles Day. The subject is considered from the standpoint of the shop engineer, whose one thought is economy. 6000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65275 D.

**Elswick Works.**

The Armstrong Works at Elswick. E. Guarini. Views, with some points in the history of the development of these works. 1200 w. Am Mach—Vol. 27. No. 35. No. 64757.

**Engine Repairs.**

An Emergency Engine Repair. Lewis F. Lyne. Illustrated description of re-

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pairs made to an engine of the center crank type, which had been wrecked by the breaking of a rod strap on the crosshead and of the connecting rod. 1100 w. Power—Sept., 1904. No. 64751 C.

**Exhausters.**

Exhausting Appliances for the Removal of Chips and Dust (Exhaustoranlagen, Insbesondere zur Beseitigung von Spänen und Staub). Hr. Geiger. A discussion of the arrangement of exhaust conveyors in wood-working establishments, with computations of the power required. 2500 w. Zeitschr d Ver Deutscher Ing—Sept. 10, 1904. No. 65113 D.

**Forging.**

Economy and Advantage of Oil Fuel for Forging. S. Uren. Read before the Nat. R. R. Master Blacksmiths' Assn. Claims that oil at 6 cents per gallon and coal at $5 per ton about balance as far as cost is concerned, but that the improvement in the quality of the iron is incalculable. 1200 w. Am Mach—Vol. 27. No. 37. No. 64974.

**Forging Press.**

The Development of the Hydraulic Forging Press (Gesichtspunkte für die Einrichtung von Schmiedepressen-Anlagen). O. Peter. A review of the application of hydraulic pressure to forging and forming operations, with numerous illustrations. Two articles, 6000 w. Glasers Annalen—Aug. 15, Sept. 1, 1904. No. 65145 each D.

**Foundry.**

Foundry of Stilwell-Bierce & Smith-Vaile Co., Dayton, Ohio. Illustrated detailed description of a foundry manufacturing principally pumps and water wheels. 1500 w. Foundry—Sept., 1904. No. 65065.

**Gear Box.**

A Milling Machine Gear Box Feed with 25 Changes. A. H. Schkommodan. Illustrated description. 600 w. Am Mach—Vol. 27, No. 38. No. 65077.

**Lathes.**

A Large Bardons & Oliver Lathe. Illustrated description of a heavy turret lathe for operating on bar stock up to six inches in diameter. 2500 w. Mach, N. Y.—Sept., 1904. No. 64771 C.

**Machine Tools.**

Specialized Machine Tools. Joseph Horner. An explanation of the present understanding of *special tools*, with illustrations of various machines and discussion of their development, value, etc. 4500 w. Cassier's Mag—Aug., 1904. No. 65005 B.

**Melting.**

Economy in Melting. J. P. Pero. A brief consideration of present practice, with suggestions for securing economy. 1500 w. Foundry—Sept., 1904. No. 65073.

**Milling.**

Planing and Milling (Hobeln und Fräsen). Dr. G. Schlesinger. A comparison of the relative advantages of planing and milling as machining processes, showing the economical advantages of the latter method of metal working. 3500 w. Zeitschr d Ver Deutscher Ing—Sept. 10, 1904. No. 65112 D.

**Milling Cutters.**

High-Spead Steel for Milling Cutters. Gives in detail results obtained with milling cutters of high-speed steel, with half-tone illustrations. 1200 w. Am Mach—Vol. 27. No. 35. No. 64756.

**Planing.**

Cutting Test on Metal Planer. J. C. Steen. Describes a cutting test made during the regular progress of the work through the shop, on a casting weighing 3,000 lbs. 700 w. Am Engr & R R Jour—Sept., 1904. No. 64792 C.

**Pneumatic Tools.**

Operative Costs of Pneumatic Tools (Betriebs Kosten der Pressluftwerkzeuge). H. Cordes. Data of the cost of using pneumatic hammers, riveters, drills and other tools in Germany. 2000 w. Glasers Annalen—Aug. 15, 1904. No. 65146 D.

**Sand.**

Molding Sand. F. J. H. Merrill. Where it is obtained, its quality, etc. 900 w. Eng & Min Jour—Sept. 1, 1904. No. 64764.

**Shops.**

Imperial Works of the Oil Well Supply Co., Oil City, Pa. Gives a map of the property and an illustrated description of these extensive works and their equipment. 2400 w. Eng Rec—Sept. 24, 1904. No. 65227.

The New Building for the General Electric Machine Shop and Power House, Lynn. An illustrated detailed description of a steel-frame building, differing materially in its structural design from many large shops. 3500 w. Eng Rec—Sept. 17, 1904. Serial. 1st part. No. 65019.

The Plant of the International Harvester Company at Hamilton, Ontario. An illustrated description of large implement works showing many new features in design, equipment and construction. 4000 w. Ir Age—Sept. 1, 1904. No. 64785.

The Schneider Works in France, with Details of the Plants at Creusot and Havre. E. Guarini. Illustrated description with brief historical review. 3000 w. Ir Trd Rev—Sept. 1, 1904. No. 64773.

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**Specifications.**

Specifications—And What They Mean to the Foundryman. David Reid. Read before the A. F. A. convention. Remarks on specifications in the foundry industry. 800 w. Foundry—Sept., 1904. No. 65071.

**Stores.**

Stores Arrangement as a Factor in Shop Management. John Ashford. The first article treats of the general plan of a system of keeping and handling stores in accordance with modern works management methods. 3000 w. Engng Mag—Oct., 1904. No. 65197 B.

**Thread Cutting.**

A Difficult Job of Square Thread Cutting. Herbert V. Purman. An illustrated detailed description of a very unusual piece of work. 2000 w. Am Mach —Vol. 27. No. 37. No. 64975.

**Tools.**

High-Speed Steel in Railroad Shops. Henry W. Jacobs. Discusses the main points to be considered in the introduction of the new alloy steel tools if beneficial results are expected. Ills. 2000 w. Am Engr & R R Jour—Sept., 1904. No. 64789 C.

The Introduction of High-Speed Steel Into a Factory. A. D. Wilt, Jr. Methods of determining the proper times, piece rates and costs due to the change from the old to the new tools. 2500 w. Engng Mag—Oct., 1904. No. 65193 B.

**Works Management.**

See Industrial Economy.

## MATERIALS OF CONSTRUCTION.

**Alloys.**

Change of Structure in the Solid State. W. Campbell. Gives a short account of the changes which occur during and after solidification in the alloys of copper and tin, iron and copper, steel and other alloys, with remarks on the importance of studying their effects. Ills. 5,000 w. Jour Fr Inst—Sept., 1904. No. 65062 D.

Some Neglected Details in the Experimental Study of Alloys. E. S. Shepherd. Points out several experimental details which have been neglected in some current researches, especially in pyrometric and metallographic work. Ills. 2500 w. Ir & Steel Mag—Sept., 1904. No. 65061 D.

**Copper.**

The Testing of Hard Drawn Copper. Lawrence Addicks. Notes the uses of hard drawn copper and the tests needed, describes the process of drawing and the method of testing. 3000 w. Elec Rev, N. Y.—Sept. 24, 1904. No. 65232.

**Ferro Alloys.**

See Electrical Engineering, Electro Chemistry.

**Heat Effects.**

The Influence of Heat Upon Mild Steel Plates (Versuche über die Festigkeitseigenschaften von Flusseisenblechen bei Gewöhnlicher und Höherer Temperatures). C. Bach. A very complete account of exhaustive experiments, with tables and diagrams. 2 articles, 7000 w. 4 plates. Zeitschr d Ver Deutscher Ing—Aug. 27, Sept. 3, 1904. No. 65109 each D.

**Impact Tests.**

Tensile Impact Tests of Metals. W. Kendrick Holt. Read before the Am. Soc. for Test. Mat. Illustrates and describes investigations made of the relative behavior of materials under impact and gradual loading and the results. 7000 w. Eng News—Sept. 8, 1904. No. 64911.

**Iron.**

Does Iron Expand? H. Sayers. Gives the reasons for the writer's conclusion that iron expands. 800 w. Foundry—Sept., 1904. No. 65070.

**Lubricants.**

Lubricating Oils and Their Properties: How to Test Them and to Direct Adulterations. W. M. Davis. 700 w. Power —Sept., 1904. No. 64749 C.

**Metallography.**

See Mining and Metallurgy, Iron and Steel.

**Metal Protection.**

Protection of Metallic Surfaces. N. Brandon. Read before the Inst. of Marine Engrs. An explanation of the action that takes place when rust is formed and the coverings used to protect metals, the conditions necessary, etc. 4000 w. Prac Engr—Sept. 9, 1904. No. 65025 A.

**Nickel-Steels.**

Allotropic Transformations of Nickel Steels. L. Dumas. Gives results of experiments at the steel works of Imply, France, in studying the influence of the allotropic condition on the properties of nickel steels. 5000 w. Ir & Steel Mag—Sept., 1904. No. 65060 D.

**Stress.**

Lecture on Recent Researches on the Effects of Stress Upon Metals. Dr. E. G. Cocker. An account of investigations which gave results of interest and importance. Ills. Also discussion. 3500 w. Pro Can Ry Club—April 5, 1904. No. 65049.

**Steel.**

Later Researches Upon Vanadium Steel (Nouvelles Recherches sur les Aciers au

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Vanadium), Léon Guillet. Showing the behavior of vanadium steels under heat treatment and demonstrating that the only useful alloys are those containing less than 0.7 per cent. of vanadium. 1000 w. Comptes Rendus—Aug. 8, 1904. No. 65124 D.

A study of Molybdenum Steel (Recherches sur les Aciers au Molybdène), Léon Guillet. Data and results of a series of systematic tests, with microphotographs of various alloys. 2000 w. Génie Civil—Aug. 13, 1904. No. 65114 D.

Properties and Constitution of Chrome Steels (Propriétiés et Constitution des Aciers au Chrome). Léon Guillet. Giving results of a series of systematic tests, both mechanical and microscopic, showing the especial value of pearlitic chrome steels for tools. 1200 w. Comptes Rendus—Aug. 16, 1904. No. 65125 D.

**Thermite.**

Industrial Uses of Thermite. Notes, with illustrations, referring to rail welding, mending machinery, etc. 1400 w. U S Cons Repts—July, 1904. No. 64744 D.

**Vibration.**

The Fracture of Structural Steel Under Alternating Stresses. Prof. J. O. Arnold. A British Association paper discussing the weakening effects of vibration upon tough steel and describing methods of tests. 1200 w. Engr, Lond.—Sept. 2, 1904. No. 64964 A.

## MEASUREMENT.

**Calorimetry.**

The Calorimetry of Gaseous Fuels. W. Garnet Wernham. Abstract of a paper read before the Junior Inst. of Engrs. Describes the method of finding the calorific value of a gas by analysis and by the direct calorimetric test, giving illustrated descriptions of various calorimeters. 4500 w. Mech Engr—Sept. 3, 1904. No. 64957 A.

**Curves.**

Curves of Performance. W. H. Booth. Some points in regard to the sizes and economies of engines. 1000 w. Power—Sept., 1904. No. 64747 C.

**Dynamometer.**

A Simple Dynamometer. W. J. Spiro. An illustrated detailed description of a dynamometer designed for use in testing a power transmission system in New York City. 3200 w. Sch of Mines Qr—July, 1904. No. 65056 D.

**Instruments.**

Some Micrometer Measuring Instruments. A. L. Monrad. Illustrated description of the writer's own design. 1800 w. Mach, N. Y.—Sept., 1904. No. 64772 C.

**Pyrometry.**

Methods of Pyrometry. C. W. Waidner. A brief treatment of the various pyrometric methods that are most widely used, with remarks on the importance of temperature control. Ills. 24600 w. Pro Engrs Soc of W. Penn—Sept., 1904. No. 65257 D.

**Testing-Machine.**

A Universal Testing Machine of 300 Tons for Full-Sized Structural Members. J. H. Wickstead. Read before the British Assn. at Cambridge. Illustrates and describes the machine, tracing the development and reporting its working. 2800 w. Engng—Sept. 2, 1904. No. 64961 A.

## POWER AND TRANSMISSION.

**Belts.**

Splicing Leather Belts. W. E. Dixon. Describes the best and most convenient method of repairing and splicing belts of all ordinary kinds. Ills. 3200 w. Power—Sept., 1904. No. 64752 C.

**Compressed Air.**

Compressed Air in Hoisting. J. S. Lane. Illustrated descriptions of machinery used in applying compressed air to hoisting and similar work, discussing its advantages and giving general information. 4400 w. Compressed Air—Sept., 1904. No. 64972.

Electrically-Driven Underground Air-Compressors (Les Compresseurs d'Air à Commande Electrique pour les Installations Souterraines). H. Denis. Showing how the advantages of electric transmission and pneumatic appliances may be combined in mining operations. Serial. Part I. 2000 w. Revue Technique—Aug. 25, 1904. No. 65129 D.

**Cranes.**

A New German Tower Electric Crane. Frank C. Perkins. Brief illustrated description of an interesting electrically operated tower crane constructed at Karlsruhe. 700 w. Sci Am—Aug. 20, 1904. No. 64740.

**Mechanical Plant.**

Proportions of the Mechanical Equipment of the Whitehall Building, New York. Floor plan of the building with description of the equipment. 2000 w. Eng Rec—Sept. 17, 1904. No. 65018.

**Power.**

Power—Economical and Otherwise. F. S. N. Macrory. Describes a gas engine plant installed in an Irish oatmeal mill, discussing its advantages and disadvan-

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tages, etc. 2500 w. Elec Engr, Lond—Aug. 26, 1904. No. 64866 A.

**Prime Movers.**

The Prime Mover Situation. Dr. Louis Bell. Considers the reciprocating engine, the steam turbine, and the gas engine, discussing recent improvements. 2300 w. Elec Rev, N Y—Sept. 17, 1904. No. 65011.

**Sanatorium Plant.**

The Power Plant of the Agnes Memorial Sanatorium. Howard S. Knowlton. An illustrated study of a power plant for an institution designed and built with great care, for the treatment of pulmonary tuberculosis, near Denver, Colo. 3500 w. Eng Rec—Sept. 10, 1904. No. 64938.

**Speed Variation.**

Something New in Speed Changing Devices. A. L. de Leeuw. An illustrated description of the device and its operation. 2300 w. Am Mach—Vol. 27, No. 36. No. 64887.

**Spiral Gearing.**

The Solution of Problems in Spiral Gearing. E. C. Oliver. Explains a method, claimed to be simple and accurate, that will solve any problem. 1200 w. Am Mach—Vol. 27, No. 36. No. 64890.

## STEAM ENGINEERING.

**Boilers.**

The Garbe Water-tube Boiler with Large Water Space (Der Garbesche Grosswasserraum Röhrenkessel). Fr. Geutsch. Describing a form of vertical water-tube boiler with large shells, with details of the forming of tube sheets, etc. 1500 w. Zeitschr d Ver Deutscher Ing—Aug. 13, 1904. No. 65103 D.

The Water-Tube Boilers of H. M. S. S. "Medusa," "Media," and "Hermes." Discusses some of the leading facts set forth in the last report of the Admiralty Committee on Naval Boilers. Deals with the Dürr, Babcock & Wilcox, and Yarrow boilers. Ills. 4000 w. Eng'ng—Aug. 26, 1904. Serial. 1st part. No. 64867 A.

Underground Boiler Plants at Pratt Coal Mines in Alabama. Erskine Ramsay. Describes the method of installation and some of the advantages realized from the arrangement. Ills. 1800 w. Mines & Min—Sept., 1904. No. 64880 C.

**Boiler Rooms.**

Boiler Room Management. Walter W. Edwards. Directions for preparing a battery of boilers for steaming. Ills. 3000 w. Am Elect'n—Sept., 1904. No. 64848.

**Boiler Scale.**

Boiler Scale and the Transmission of Heat. A. D. Risteen. Shows that many statements made in regard to the efficiency of boilers being seriously impaired by scale are not true, but that scale is objectionable because it raises the temperature of the boiler plate. 3500 w. Am Mfr & Ir Wld—Sept. 15, 1904. No. 65007.

**Breakdowns.**

Engine Breakdowns and Their Lessons. Michael Longridge. From the annual report of Michael Longridge, chief engineer of the British Engine, Boiler and Electrical Insurance Company, Ltd. Ills. 6000 w. Mech Engr—Aug. 27, 1904. No. 64857 A.

**Chimneys.**

Steel Chimneys and Their Construction. E. C. Sherman. Briefly explains the object of chimneys and how to compute the height and area, and gives particulars in regard to guyed and self-supporting steel chimneys. Ills. 1800 w. Engr, U S A—Sept. 1, 1904. No. 64821 C.

**Clearance.**

Clearance Reducing Valve Mechanism and Cylinder. Reviews the work in this field by J. B. Alfree and Ira C. Hubbell, giving illustrated description of their system. 2200 w. Ry Mas Mech—Sept., 1904. No. 64931.

**Compound Engines.**

The Effects of Receiver Drop in a Compound Engine. Joseph W. Hayward. Read before the British Assn. Deals with the results of four experiments, undertaken to demonstrate the effects of varying the point of cut-off in the low-pressure cylinder of a compound engine, other conditions being maintained constant. 700 w. Engr, Lond—Aug. 26, 1904. No. 64873 A.

**Corrugated Furnaces.**

The Relative Elasticity of the Fox and Morison Corrugated Boiler Furnaces (Versuche über die Verschiedenheit der Elastizität von Fox und Morison Wellrohren). C. Bach. Data and results of experimental tests, giving the longitudinal elasticity of both types under various stresses. 1500 w. Zeitschr d Ver Deutscher Ing—Aug. 13, 1904. No. 65104 D.

**Costs.**

Steam Costs in Industrial Combinations. William D. Ennis. A study of a systematic method of computing the cost of steam power from its various elements. 3000 w. Engineering Magazine—October, 1904. No. 65196 B.

**Counterbalancing.**

Balance Cylinders, Luther D. Lovekin. An illustrated article explaining the problem which confronts a true balance cylinder, and considering the forces to be overcome, and the applications made. 3500 w. Jour Am Soc of Nav Engrs—Aug., 1904. No. 65204 H.

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**Engines.**

New Design of Bates-Corliss Engine. An illustrated description of this new design, calling attention to the improvements. 1200 w. Engr, U S A—Sept. 15, 1904. No. 64976 C.

Tandem Compound Drop Valve Steam Engine. Illustrated description of a new type of engine. The special features are a positive valve-gear motion of a simple type, with very strong construction. 700 w. Engr, Lond—Sept. 2, 1904. No. 64962 A.

The 5,000-Horse-Power Engine at the World's Fair. C. J. Larson. Illustrated description of this powerful steam-electric unit and features involved in the installation. 3000 w. Eng Rec—Sept. 10, 1904. No. 64936.

**Entropy.**

Entropy in Steam Engine Practice. A study of the temperature-entropy diagram is given in the present number. 1700 w. Mech Engr—Aug. 27, 1904. Serial. 1st part. No. 64856 A.

**Feed Water.**

Feeding Steam Boilers. R. T. Strohm. Reviews the methods of supplying feed water, discussing their limitations. Ills. 2800 w. Am Elect'n—Sept., 1904. No. 64845.

**Firing.**

Progress in the Technology of Firing (Ueber Fortschritte in der Feuerungstechnik). Gustav Deutsch. A discussion of the firing of boiler furnaces, with special reference to underfeed stokers. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 2, 1904. No. 65151 D.

**Liquid Fuel.**

The Science of Burning Liquid Fuel. W. N. Best. Considers some of the advantages of this fuel over others, and how to obtain the best results. 1600 w. Sci Am Sup—Aug. 20, 1904. No. 64741.

See Marine and Naval Engineering.

**Steam Heating.**

See Mechanical Engineering, Heating and Cooling.

**Superheating.**

European Practice in the Use of Superheated Steam. Franz Koester. Reviews the history of its use and describes examples of modern engine equipment. 2200 w. Power—Sept., 1904. Serial. 1st part. No. 64755 C.

The Action of Superheated Steam in Reciprocating Engines (Fonctionnement de la Vapeur Surchauffeé dans les Machines à Pistons). F. Richter. A French translation by M. Lecuir, of Prof. Richter's important experimental researches at Charlottenburg. 10,000 w. Revue de Mécanique—Aug. 31, 1904. No. 63134 E + F.

The Pielock Superheater for Locomotives. Illustrated description of a superheater which is a strong competitor of the Schmidt in Germany. Also editorial. 1800 w. Ry Age—Sept. 9, 1904. No. 64899.

Superheated Steam for Locomotives in Germany. An account of what has been accomplished in this field. 4000 w. U S Cons Repts—July, 1904. No. 64745 D.

**Turbines.**

A Review of Steam Turbine Patents. Illustrates and describes types selected from the great number of patents, from 1827 to date. 3800 w. Mach, N Y—Sept., 1904. Serial. 1st part. No. 64769 C.

The Steam Turbine of the Allgemeine Elekticitäts Gesellschaft, Berlin. (Die Dampfturbinen der Allgemeinen Elektricitäts-Gesellschaft, Berlin). O. Lasche. A detailed account of the construction and manufacture of the steam turbine and turbine generating sets of the General Electric Company of Berlin. Two articles, 6000 w. Zeitschr d Ver Deutscher Ing—Aug. 13, 20, 1904. No. 65100 each D.

The Steam Turbine (Les Turbines à Vapeur). G. Hart. A general review of the development of the steam turbine, discussing the theory, and reviewing the various types. 30,000 w. 1 plate. Mem Soc Ing Civ de France—June, 1904. No. 65133 G.

The Zoelly Steam Turbine (Die Dampfturbine von Zoelly). Giving details of construction and regulation of the turbine built by Escher, Wyss & Co., of Zürich. 2500 w. Elektrotech Zeitschr—Sept. 8, 1904. No. 65163 B.

Warren-Crocker Steam Turbine. E. C. Crocker. Read before the Ohio Elec. Lgt. Assn. Describes the construction and governing and discusses the adaptation. 1500 w. Engr, U S A—Sept. 15, 1904. No. 64977 C.

**Valves.**

Valves and Valve Gears. Robert Gibson Griswold. An illustrated analysis of the various gears, with a careful study of the simple "D" slide valve and its effect upon the steam distribution and formation of the diagram. 2800 w. Power—Sept., 1904. Serial, 1st part. No. 64750C.

## MISCELLANY.

**Aeronautics.**

The Contour Aeronaut (L'Aéronat F. Contour). H. de Graffigny. Describing a new dirigible balloon, now being constructed in Paris. 1200 w. Revue Technique—Aug. 25, 1904. No. 65130 D.

The "Lebaudy II." Emile Guarini. An illustrated article describing this airship and giving an account of its recent breaking from its moorings and upward flight. 1300 w. Sci Am—Sept. 24, 1904. No. 65084.

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# MINING AND METALLURGY

## COAL AND COKE.

**Canada.**

The Development of Coal Mining in Canada. William Blakemore. A report on the abundance of coal in most parts of Canada, and its effect on the industries. 1500 w. Can Min Rev—Aug. 31, 1904. No. 64840 B.

**Coal Testing.**

The Coal Testing Plant of the Survey. E. W. Parker. Illustrated description of the plant at Louisiana Purchase Exposition. 3500 w. Eng & Min Jour—Sept. 15, 1904. No. 64992.

**Coke.**

The Manufacture of Coke in Peru. J. Morgan Clements. Brief illustrated description of the method of coking. 500 w. Trans Am Inst of Min Engrs—Sept. 1904. No. 65264.

**Coke Plant.**

The New No. 3 Coke Plant of the Oliver & Snyder Steel Co. An illustrated description of a complete modern plant and its equipment. 1200 w. Mines & Min—Sept., 1904. No. 64883 C.

**Coking.**

The Installation of an Underfired Coke-Oven Plant (Die Inbetriebsetzung einer Unterfeuerungs-Koksofenanlagen). Alois Czermak. Describing the operation of a by-product coke oven designed for a hard-coking coal. Two articles. 3000 w. Oesterr Zeitschr f. Berg u Hüttenwesen—Aug. 27, Sept. 3, 1904. No. 65140 each D.

**Colliery.**

The South Wilkes-Barre Colliery. Illustrates and describes one of the most gaseous mines in the anthracite region, the general plan of working, means of ventilation, and precautions to prevent mine fires. 1800 w. Eng & Min Jour—Sept. 22, 1904. No. 65206.

**Cumberland Gap.**

The Cumberland Gap Coal Field. George H. Ashley. An illustrated article describing this area, its geology and development. Map. 2200 w. Min Mag—Aug., 1904. No. 65201 C.

**Exhibits.**

Coal Mining at the Louisiana Purchase Exposition. Illustrated description of models showing works of some of the large bituminous coal companies. 2500 w. Mines & Min—Sept., 1904. No. 64885 C.

**Gob-Fires.**

The Problem of Gob-Fires. George Farmer. Read before the Inst. of Min. Engrs. Deals with spontaneous combustion and the problem of gob-fires, their cause, prevention, and extinction. Discussion. 4500 w. Ir & Coal Trds Rev—Sept. 16, 1904. No. 65251 A.

**Peat.**

Possibilities of Peat as Fuel. Describes recent methods used in Germany for utilizing peat and other waste products as fuel. 1500 w. Sci Am—Sept. 10, 1904. No. 64916.

**Pinxton Collieries.**

The Applications of Electricity at the Pinxton Collieries. Describes the extensive application of electricity in these English collieries. Ills. 4200 w. Elect'n, Lond—Sept. 9, 1904. No. 65030 A.

**Safeguards.**

Safeguards in Bituminous Coal Mining. W. E. Fohl. Considers that the laws regulating the mining of bituminous coal need regulating and offers some suggestions, urging particularly the need of uniformity. Discussion. 11000 w. Pro Engrs' Soc of W Penn—July, 1904. No. 65052 D.

**Tipples.**

The Use of Steel for Coal Mine Tipples, and a Classification of Same. George S. Rice. Discusses the various questions relating to coal tipples, from an experience in the western part of the United States. Ills. General discussion. 11000 w. Jour W Soc of Engrs—Aug., 1904. No. 65093 D.

**Virginia.**

The Big Stone Gap Coal-Field of Virginia and Kentucky. J. L. Pultz. Describing a district which is developing into an important centre for the production of furnace coke. 3500 w. Engineering Magazine—October, 1904. No. 65195 B.

## COPPER.

**Mining Methods.**

Mining Methods in the Vermilion and Mesabi Districts. Kirby Thomas. A general description, with illustrations, of the methods used in these mines of copper and iron. 4000 w. Min Wld—Aug. 27, 1904. No. 64729.

**Montana.**

The Casual Observer at Anaconda. Charles S. Palmer. Illustrated brief description of this copper reduction plant, the largest in the world—The Washoe

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smelter. 2500 w. Eng & Min Jour—Sept. 22, 1904. No. 65209.

**Lake Superior.**

Peculiarities of Lake Superior Copper Production. Horace J. Stevens. A summary of the interesting features of this region, with map. 3500 w. Min Wld—Aug. 27, 1904. No. 64730.

## GOLD AND SILVER.

**Amalgamation Test.**

Testing Gold-Ores by Amalgamation. Ernest A. Hersam. Considers methods of amalgamated iron, especially describing a method by which the amalgamated gold is to be recovered, weighed and thus determined directly. 10000 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 65262 C.

**Assaying.**

A Crucible Charge for Gold and Silver in Zinc Ores. E. J. Hall and E. Popper. A report of investigations made to eliminate troubles in the scorification method of assaying zinc ores for the precious metals. 500 w. Sch for Mines Qr—July, 1904. No. 65057 D.

Fire Assaying. Evans W. Buskett. Describes the apparatus commonly used and the methods, the reagents, and some of the reactions. Ills. 2800 w. Mines & Min—Sept., 1904. No. 64884 C.

The Determination of Silver in the Sulphide Ores and Concentrates of the Slocan. D. Lay. A comparison of pot and scorification assays. 2000 w. B C Min Rec—Sept., 1904. No. 64895 B.

**Briquetting.**

A Bricking Plant for Flue Dust and Fine Ores. Jas. C. Bennett. Illustrates and describes the plant for briquetting ores at the Selby Smelter, San Francisco. 1100 w. Eng & Min Jour—Sept. 15, 1904. No. 64993.

**Chile.**

Notes on the Gold District of Canutillo, Chile. S. A. Sydney H. Loram. A descriptive account of the development of a district but little known. Ills. 4000 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 65259.

**Cyanide.**

Cyaniding in the Black Hills. J. T. Milliken. A description of the process practiced at the Imperial mine. 2000 w. Min & Sci Pr—Sept. 10, 1904. No. 65021.

The Cyanide Practice of the Cripple Creek District. G. E. Wolcott. An account of the practical application of the cyanide process in this district. The present outlook seems favorable, but it has only been in use about one year. 1800 w. Min Rept—Sept. 1, 1904. No. 64834.

**Mexico.**

The Taviche Mining District near Ocotlan, State of Oaxaca, Mexico. H. M. Chance. Brief review of the history of these mines, the methods of working, etc. The ores are siliceous, consisting principally of quartz carrying gold and silver. 2200 w. Trans Am Inst of Min Engs—Sept., 1904. No. 65260.

**Milling.**

Notes on Mill Construction Milling and Amalgamation. Discussion of paper by J. Roskelly. 4200 w. Jour of the Chem Met & Min Soc of S Africa—July, 1904 No. 64953 E.

**Mother Lode.**

The Mother Lode in Tuolumne County, California. W. H. Storms. Illustrated description of the geological and mineralogical characteristics of this gold-bearing formation. 1500 w. Min & Sci Pr—Sept. 17, 1904. No. 65223.

**Nevada.**

The District of Goldfield, Nevada. Marshall D. Draper. Illustrated description of a mining camp that has marketed over $700,000 worth of ore in about seven months though poorly equipped. 2000 w. Eng & Min Jour—Sept. 8, 1904. No. 64,903.

**New Zealand.**

Milling and Treatment of Auriferous Ores in New Zealand. H. A. Gordon. Abstract of a paper in Trans. of the Aust. Inst. of Min. Engrs. Describes the ores and the treatment given them. 6500 w. N Z Mines Rec—June 16, 1904. No. 64951 B.

Water in the Hauraki Gold-Field, New Zealand. Percy Morgan. Information in regard to these mines where water is always encountered immediately below the drainage level of the surface and requires the use of pumps. 1800 w. Eng & Min Jour—Sept. 15, 1904. No. 64994.

**Ore Deposits.**

The Geology of the Treadwell Ore-Deposits, Douglas Island, Alaska. Arthur C. Spencer. A description of the Treadwell gold-deposits in their geological aspects, with an outline of the general geological features of the region. Ills. 13000 w. Trans Am Inst of Min Engrs—Oct., 1904. No. 65258 C.

**Precipitation.**

Electrical Precipitation in Montana. Matt. W. Alderson. An illustrated description of this method of treatment adopted to overcome difficulties in securing perfect precipitation. 1200 w. Min & Sci Pr—Aug. 27, 1904. Serial. 1st part. No. 64825.

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**Queensland.**

Notes on Tin, Copper, and Silver Mining in the Stanthorpe District. Lionel C. Ball. An illustrated article, the present number deals with methods of tin mining. 8800 w. Queens Gov Min Jour—July 15, 1904. Serial. 1st part. No. 64849 B.

The Carters Towers Mines. S. Horsley. Report on their ventilation and sanitary arrangements. 6600 w. Queens Gov Min Jour—July 15, 1904. Serial. 1st part. No. 64850 B.

**Roasting.**

Chloridizing Roasting of Silver Ores in Mexico. Ernest Stein. Describes the working of the reverberatory furnaces. 2300 w. Eng & Min Jour—Sept. 1, 1904. No. 64767.

**Sampling.**

The Sampling of Ore as Practiced in the Cripple Creek District. C. E. Wolcott. Describes the methods practiced in one of the greatest gold camps, where sampling is of particular importance. 1300 w. Min Rept—Sept. 8, 1904. No. 64934.

**Siberia.**

Gold Mining in Siberia. J. H. Curle, in the London *Economist*. Information concerning these mines, and a discussion of racial, political and economic reasons why the writer considers them unfavorable for foreign investments. 1500 w. Eng & Min Jour—Sept. 15, 1904. No. 64997.

**Slimes.**

The Separation of Sands from Slimes. From Bulletin No. 7, of the South Dakota School of Mines. Describes the method used. 1500 w. Min Rept—Sept. 15, 1904. No. 65046.

**Smelting.**

The Custom Smelting Industry in Mexico. James W. Malcolmson, in the *Lead and Zinc News*. On the growth of the silver-lead smelting industry in Mexico, and the advantages of copper matte over lead as a vehicle for the concentration of gold and silver contained in silicious ores. 1500 w. Can Min Rev—Aug. 31, 1904. No. 64842 B.

**Sulphides.**

The Potter Process. Donald Clark. Illustrates and describes a machine for the separation of sulphides from gangue by this process. 1400 w. Eng & Min Jour—Sept. 8, 1904. No. 64907.

**Thunder Mountain.**

Notes on Thunder Mountain, Idaho. Brief descriptions of the mines and camps of this region. 3000 w. Eng & Min Jour—Sept. 8, 1904. No. 64906.

**Tube Mills.**

The Tube Mill in the Transvaal. An account of results of tests being made on the Rand. The experiments have been so successful that there is reasonable expectation of increasing the production, improving the extraction, and lowering the cost. 1800 w. Engr, Lond—Sept. 9, 1904. No. 65040 A.

**Witwatersrand.**

The Klerksdorp District. T. Lane Carter. Information of interest concerning this district. Ills. 1400 w. Eng & Min Jour—Sept. 22, 1904. No. 65207.

## IRON AND STEEL.

**Electro-Metallurgy.**

See Electrical Engineering, Electrochemistry.

**England.**

A French View of the English Iron Industry. E. de Billy and J. Milius, on *Revue de Metallurgie*. Considers the natural conditions under which the industry has developed, the features of the different districts, and British equipment and organization. 2500 w. Ir Age—Sept. 1, 1904. No. 64787.

**Ferro Alloys.**

See Electrical Engineering, Electro-Chemistry.

**Hematite.**

Brown Hematite Deposits of Eastern New York and Western New England. Edwin C. Eckel. A study of the deposits in the counties of Dutchess and Columbia. N. Y.; Berkshire, Mass., and Litchfield, Conn. Ills. 2800 w. Eng & Min Jour—Sept. 15, 1904. No. 64996.

**Iron Ores.**

The Analyzing and Grading of Iron Ores. Edward A. Separk. Abstract of a paper prepared for the meeting of the Lake Superior Min. Inst. Describes the methods used with the ores of the Oliver Iron Mining Co. The samples are taken underground. 2500 w. Eng News—Sept 1, 1904. No. 64797.

See Industrial Economy.

**Limonite.**

The Genesis of Limonite Ores in the Appalachians. F. Lynwood Garrison. A geological study. 2800 w. Eng & Min Jour—Sept. 22, 1904. No. 65208.

**Metallography.**

Notes on Metallography. William Campbell. On the present methods of research, particularly in iron and steel. 8500 w. Sch of Mines Qr—July, 1904. No. 65059 D.

The Plastic Yielding of Iron and Steel. Walter Rosenhain. Read before the Iron & Steel Inst. Deals with the lines of argument advanced by various writers in re-

cent papers, examining the evidence on which their views are based. 3300 w. Engng—Sept. 9, 1904. Serial, 1st part. No. 65038 A.

**Methods.**

Modern Methods of Making Iron and Steel. Brief review of the history, showing Pennsylvania's part in their introduction. 2000 w. Bul of Am Ir & St Assn —Sept. 10, 1904. No. 64874.

**Mexico.**

Some Notes on the Cerro Mercado. Oliver Cummings Farrington. Illustrations and information of this hill in Mexico, which is largely made up of solid iron ore. Considers its origin, the uses made of the ore, etc. 2000 w. Eng & Min Jour —Sept. 1, 1904. No. 64766.

**Nickel Steels.**

See Mechanical Engineering, Materials.

**Ontario.**

The Exploration of the Ontario Iron Ranges. A. B. Willmott. Read before the Can. Min. Inst. Discusses the surface indications of undiscovered iron ore deposits, and the best methods of exploration. 3000 w. Can Min Rev—Aug. 31, 1904. No. 64841 B.

**Pig Iron.**

Some Examples of Irregular Distribution of Sulphur in Pig Iron. John J. Porter. Read at the A. F. A. convention. Describes some very remarkable cases of segregation of sulphur found in analyzing a large number of pigs of iron. 600 w. Foundry—Sept., 1904. No. 65067.

**Russia.**

The Iron Industry of Russia (Russische Eisenindustries). A review of the present output of iron and steel, with data as to costs and quality. Two articles, 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 13, 20, 1904. No. 65136 each D.

**Scandinavia.**

Iron Ore Mining in Scandinavia. W. Fischer Wilkinson. Abstract of a paper read before the Inst. of Min. & Met., England. On the character and extent of the deposits, considering Dunderland, Kirunavaara, and Gellivara. Map. 3000 w. Ir Age—Sept. 1, 1904. No. 64786.

**Slag.**

The Granulation of Blast-Furnace Slag (Zur Granilierung der Hochofenschlacke). R. Schöffel. A discussion as to the influence of the water upon the granulation of slag discharged into it. 1000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 20, 1904. No. 65139 D.

**Steel Works.**

Notes on American Steel Works. David E. Roberts. Illustrated notes dealing principally with details which seem to the writer of practical interest, and confined to rolling mills. 1800 w. Engng—Sept. 9, 1904. Serial. 1st part. No. 65036 A.

## MINING.

**Boilers.**

See Mechanical Engineering, Steam Engineering.

**British Columbia.**

Mining in British Columbia. Arthur Lakes. Describes the country, mining districts, labor conditions, etc. The deposits are gold, silver, copper, lead and zinc. Ills. 1700 w. Min Rept—Sept. 15, 1904. No. 65045.

**Conveyor.**

The Aërial Ropeway at Aberfeldy. Illustrated description of a new aërial ropeway in Scotland, for the conveyance of stone from the quarries, a distance of 2¼ miles. 600 w. Engr, Lond—Sept. 2, 1904. No. 64965 A.

**Electric Pumping.**

A French Electrically-Operated Mine—Pumping Installation. Frank C. Perkins. An illustrated description of a recently installed plant in Belgium. 700 w. Min Rept—Sept. 22, 1904. No. 65234.

**Faulting.**

Faulting at Ballarat East. T. S. Hart. Calls attention to the nature of the movement on the dip-faults, and the effect on the disposition of the rich ore. 3800 w. Aust Min Stand—July 28 and Aug 4, 1904. Serial. 2 parts. No. 64852 each B.

**Outcrop.**

Field Notes. Prof. Arthur Lakes. Concerning ore shoots and the influence of down-hill pressure on the outcrop of veins. Ills. 2400 w. Mines & Min—Sept., 1904. No. 64886C.

**Quarries.**

Economic Points in Quarry Practice. O. H. Howarth. Remarks on the action of explosives, and methods of estimating the direction and amount of rock pressure. 5000 w. Mines & Min—Sept., 1904. No. 64879 C.

**Respiration.**

The Latest Improvements in Artificial Respiration. Apparatus (Die Jüngste Entwicklung der Atmungsapparate). G. A. Meyer. An account of the improved respiration devices, using oxygen and absorbing the carbonic acid by caustic potash. The trials in the Shamrock mines are described. 10,000 w. Glückauf—Sept. 3, 1904. No. 65144 D.

**Rock Drills.**

Trials of Rock Drills. J. B. Carper

*We supply copies of these articles. See page 319.*

Data on trials showing relative air consumption per cubic inch of rock drilled by different makes of drills. 3500 w. Mines & Min—Sept., 1904. No. 64881 C.

**Sampling.**

Mine Sampling. G. W. Miller. On sampling, testing and valuing of ores, their classification, requirements of a mine examiner, etc. Ills. 1800 w. Ores & Metals—Sept. 1, 1904. Serial, 1st part. No. 64820.

**Shafts.**

Sinking Through Quicksand at the Susquehanna Mine. H. B. Sturtevant. Read before the Lake Superior Min. Inst. Describes the methods used and progress made. Ills. 1500 w. Eng & Min Jour—Sept. 1, 1904. No. 64765.

The Lining of Old Shafts with Reinforced Concrete (Eisenarmierte Betonausbau alter Schachte). Ant. Schimitzek. Describing the successful replacement of old timbering with reinforced-concrete lining. 1000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 20, 1904. No. 65138 D.

**Signalling.**

Mine Signalling by Compressed Air. Describes the pull bell system in general use, and gives an illustrated detailed description of the compressed air signal system which is a modification of the system used on express trains. 2500 w. Ir & Coal Trds Rev—Sept. 2, 1904. No. 64966 A.

**Timbering.**

Timber and Timbering. J. H. Batcheller. Describes the methods in use at the Bunker Hill and Sullivan mines, in the Coeur d'Alene district, of Idaho. Ills. 1700 w. Eng & Min Jour—Sept. 15, 1904. Serial, 1st part. No. 64995.

**Traction.**

Electric Gathering Locomotive. An adaptation of the ordinary trolley locomotive so that it may enter rooms in which wires have not been installed, is illustrated and described. 1500 w. Mines & Min—Sept., 1904. No. 64878 C.

Pneumatic Traction in Mines in the United States (La Traction Pneumatique dans les Mines des Etats Unis). A de Gennes. With illustrations of compressors and compressed-air locomotives and data as to efficiency and cost. 5000 w. 1 plate. Mem Soc Ing Civ de France—June, 1904. No. 65132 G.

**Veins.**

The Formation of Veins. J. F. Kemp. A brief statement of general principles, reviewing the views of noted geologists. 2500 w. Min Mag—Aug., 1904. No. 65,200 C

**Ventilators.**

A Guibal Fan with Volute Casing. E. Lagage. Translated from the *Revue Universelle des Mines.* Illustrates and describes a fan installed in French mines. 800 w. Eng & Min Jour—Sept. 1, 1904. No. 64763.

Centrifugal Ventilators. R. V. Norris. On the design and tests of the Luke-Fidler colliery fan, with comparison of results and conclusions reached. Ills. 2800 w. Trans Am Inst of Min Engrs—Sept., 1904. No. 65261.

**Winding.**

An Electric Winding Engine with Safety Appliances (Ein Elektrisch Anbetriebener und mit Allen Sicherheits-vorrichtungen Ausgerüsteter Förderhaspel). H. Koch. Illustrating an electric winding engine for a depth of 169 metres and a speed 5 metres per second; using a polyphase motor. 1000 w. 1 plate. Oesterr Zeitschr Berg u Hüttenwesen—Aug. 20, 1904. No. 65137 D.

Comparison Between Direct Current and Polyphase Systems for Electric Winding Plant. John G. Hooghwinkel. Deals principally with a case where there is a separate power station for the winding plant, considering the first cost of a direct current and a polyphase equipment, and pointing out the advantages and disadvantages of each. 1800 w. Elec Engr, Lond.—Sept. 16, 1904. No. 65241 A.

Computations for Electrically Driven Winding Engines (Die Berechnung der Elektrisch Betriebenen Hauptschacht-Fördermaschine). V. Graubner. Discussing the power required and the proportions for electric motors of various types. Serial. Part I. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 10, 1904. No. 65141 D.

The Hoisting Problem. James R. Thompson. Discusses the problem in regard to the underground requirements, its engineering and mechanical features, and the financial side; especially considering the Lake Superior region. 5500 w. Min Wld—Sept. 10, 1904. No. 64927.

The Problem of Dynamic Balance. E. H. Roberton. An investigation of single, double and quadruple stage winding from a depth of 4000 feet. Ills. 3800 w. Ir & Coal Trds Rev—Sept. 16, 1904. No. 65252 A.

## MISCELLANY.

**Asbestos.**

Production of Asbestos During 1903. Joseph Hyde Pratt. On the uses of asbestos and the origin of the chrysotile variety. 4800 w. Min Wld—Sept. 17, 1904. No. 65023.

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**China.**

The Mineral Resources and Metallurgical Processes of Northern China (Richesses Minerales et Procédés Métallurgiques du Chan-si, Chine Septentrionale). A description of the Chan-si district and its mineral resources of iron and coal. 2000 w. Génie Civil—Sept. 10, 1904. No. 65121 D.

**Diamonds.**

Diamond Mining in the Transvaal. From the London *Economist*. The effect of the development of the Premier Diamond Mine on the diamond market. 2000 w. Aust Min Stand—July 21,1904. No. 64851 B.

The Genesis of the Diamond. Gardner F. Williams. Describes the physical properties of the diamond; where they are found, the theories as to their origin and the weak spots in them are considered. 5000 w. Trans Am Inst of Min Engrs—Sept., 1904. No. 65263.

**Explorations.**

Exploration in the Sudan and Abyssinia. A. H. Ackermann. Illustrations, with description of the country, transport difficulties, climate, labor, etc. 1500 w. Eng & Min Jour—Sept. 8, 1904. No. 64905.

**Ice Sheets.**

Crystosphenes. J. B. Tyrrell, in the *Journal of Geology*. An explanation of how the buried sheets of ice found in the tundra of Northern America are formed. 2000 w. Aust Min Stand—Aug. 11, 1904. No. 65238 B.

**Nickel.**

The Nickel Deposits of Norway. Major R. G. Leckie. Read before the Can. Min. Inst. Describes the geological formations of Norway, the ore deposits and particularly the nickel mines in the southern part. 2500 w. Can Min Rev—Aug. 31, 1904. No. 64839 B.

**Petroleum.**

Refining of California Petroleum. Paul W. Prutzman. Read before the Pacific Coast Gas Assn. Brief account of the production in California, describing the apparatus of a refinery and the methods used and giving much information of the products. General discussion. Ills. 10500 w. Pro Age—Sept. 15, 1904. No. 64979.

**Quicksilver.**

The Quicksilver Deposits of California. William Forstner. A study of the formation and characteristics of these deposits. 3000 w. Eng & Min Jour—Sept. 8, 1904. Serial. 1st part. No. 64904.

**Salt.**

Rock Salt Mining. W. R. Crane. Illustrated description of the deposit and the methods employed at the plant of the Royal Salt Co., at Kanopolis, Kansas. 2000 w. Mines & Min—Sept., 1904. No. 64882 C.

The Desert Dry Lakes of California. G. E. Bailey. Notes on these saline lakes and the value of their deposits, and the importance of protecting and preserving them. 2200 w. Min & Sci Pr—Aug. 27, 1904. Serial. 1st part. No. 64826.

**Tungsten.**

Tungsten Ores in the Black Hills. Jesse Simmons. Information concerning these deposits and their mode of formation. 1300 w. Min Rept—Sept. 1, 1904. No. 64835.

**Zinc.**

Hedburg's Simplex Process for Separating Refractory Zinc Ores. Robert T. Clegg. Illustrates and describes a plant for separating iron sulphide from zinc blende. 1500 w. Min Wld—Sept. 10, 1904. No. 64928.

Notes on the British Columbian Zinc Problem. Alfred C. Garde. Extract from a paper used before the Canadian Mining Institute. Information concerning the mines and ores and their treatment. 1700 w. B C Min Rec—Sept., 1904. No. 64894 B.

The San Juan Country as a Zinc Producer. Samuel W. Osgood. Information concerning the zinc mines of the Rocky Mountains. Ills. 1800 w. Min Wld—Sept. 17, 1904. No. 65022.

See Electrical Engineering, Electro-Chemistry.

# RAILWAY ENGINEERING

## CONDUCTING TRANSPORTATION.

**Collisions.**

A Panacea for One Class of Butting Collisions. H. W. Forman. Considers the present method of moving trains on a very busy single track railroad, with suggestions for insuring greater safety. 2000 w. R R Gaz—Vol. XXXVII. No. 12. No. 64778.

**Long Run.**

A Long Run Without a Stop. H. A. B. Campbell. Gives running time of the trains between London and Plymouth, with remarks on the service. The dis-

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tance is 246 miles and the grades severe. 1300 w. R R Gaz—Vol. XXXVII. No. 14. No. 64998.

**Train Rules.**

An Explanation of Form F. An explanation and discussion. 2200 w. R R Gaz—Vol. XXXVII. No. 14. No. 65003.

## MOTIVE POWER AND EQUIPMENT.

**Auto Car.**

The Ganz Rail Auto Car. An illustrated description of a car designed by Ganz & Co., of Budapest. 800 w. R R Gaz—Vol. XXXVII. No. 12. No. 64774.

**Braking.**

Braking High-Speed Trains. R. A. Parke. Claims that materially increased stopping efficiency may with propriety be employed in high-speed train service. Assumes the use of the automatic air brake. 2400 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65265 D.

**Car Ventilation.**

The Passenger Car Ventilation System of the Pennsylvania Railroad. Outlines the system adopted, after much experimental work. Ills. 2500 w. Eng Rec—Sept. 24, 1904. No. 65228.

**Coupler.**

The Westinghouse Automotic Air and Steam Coupler. Illustrated description of this interesting exhibit at St. Louis. 1200 w. R R Gaz—Vol. XXXVII. No. 14. No. 65002.

**High Speeds.**

High Speeds on Steam Railways (Les Grandes Vitesses sur les Chemins de Fer). R. Bonnin. Describing some of the steam locomotives recently designed in Germany for the attainment of high speeds. 3500 w. Revue Technique—Sept. 10, 1904. No. 65131 D.

**Locomotives.**

Atlantic Locomotive for the Wabash. Illustrated description. 400 w. Ry Age—Sept. 9, 1904. No. 64900.

A Western Pioneer. J. A. Baker. Illustration, with information concerning a Stevens engine on the Southern Pacific. 500 w. Loc Engng—Sept., 1904. No. 64799 C.

Experiments and Observations Made on the Locomotives of the Danish State Railway. O. Busse, in the *Organ für die Fortschritte des Eisenbahnwesens.* 2000 w. Bul Int Ry Cong—Aug., 1904. No. 65082 F.

Four-Cylinder Compound Locomotive. Illustration, with brief description of the engine at the St. Louis Exhibition representing the Von Borries balanced system. 1200 w. Engr, Lond.—Sept. 9, 1904. No. 65042 A.

High-Speed Tank Locomotive for Mountain Service (Schnellzug-Tenderlocomotive für Gebirgsbahnen). Describing a four-cylinder compound engine with superheater for heavy mountain service, built by Henschel & Son, of Cassel, Germany. 2500 w. 1 plate. Zeitschr d Ver Deutscher Ing—Aug. 27, 1904. No. 65108 D.

High-Speed Three-Cylinder Compound German Locomotive. Illustrated description of an engine on exhibition at St. Louis which is entirely inclosed above the running board in a continuous steel housing wedge-shaped at the front end, for the purpose of reducing air resistance. 2200 w. Ry Mas Mech—Sept., 1904. No 64930.

Locomotive for the Londonderry and Lough Swilly Railway. Illustrated detailed description. 900 w. Engng—Aug. 26, 1904. No. 64868 A.

Modern Locomotives at the St. Louis Exposition. A double-page engraving of a series of the more interesting exhibits, with remarks on the various types. 2500 w. Sci Am—Sept. 17, 1904. No. 64986.

New Type of Compound Locomotive, Adriatic System, of Italy. Drawings and description of novel engines of excellent efficiency. 1300 w. Ry & Engng Rev—Sept. 10, 1904. No. 64926.

Passenger Locomotive, Michigan Central Railroad. An illustrated description of a 4-6-2 (Pacific) type. 1000 w. Am. Engr & R R Jour—Sept., 1904. No. 64791 C.

Suburban Engine for the Long Island Railroad. Brief illustrated description of a suburban tank locomotive of the Prairie or 2-6-2 type. 500 w. Loc Engng—Sept., 1904. No. 64798 C.

The Development of the Compound Locomotive in England. W. E. Dalby. Professor Dalby's second article deals with the compound engines of the Northeastern, Midland and Great Northern railways, with details and data of performances. 3000 w. Engng Mag—Oct., 1904. No. 65192 B.

The New Compound Locomotives of the Paris Belt Line (Les Nouvelles Locomotives Compound du Chemin de Fer de Ceinture, à Paris). F. Barbier. Illustrating and describing the four-cylinder, tandem, compound engines designed by M. du Bousquet for the special service of the Paris belt line. 2000 w. 1 plate. Génie Civil—Sept. 10, 1904. No. 65120 D.

The Schenectady Super-Heater Locomotive. Brief illustrated description of the design of F. J. Cole. 1400 w. Am Engr & R R Jour—Sept., 1904. No. 64790 C.

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**Motor Coaches.**

Steam Motor Coaches, Midland Railway. Illustrated description of the self-propelled steam railway coaches being run between Morecambe and Heysham. 1800 w. Engr, Lond.—Aug. 26, 1904. No. 64871 A.

**Private Cars.**

A Handsome Private Car. Illustrated description of a fine car built for exhibition at St. Louis. 700 w. Ry Age—Sept. 9, 1904. No. 64902.

**Steaming.**

Investigations Upon the Steaming Capacity of Locomotives and the Composition of Flue Gases (Rauchgasanalysen und Verdampfungsversuche an Lokomotiven). H. Strahl. A study of combustion and steaming in locomotives, with the practical application of the Orsat apparatus to the flue gases. Two articles, 9000 w. Glasers Annalen—Sept. 1, 15, 1904. No. 65147 each D.

**Superheating.**

See Mechanical Engineering, Steam Engineering.

**Train Lighting.**

The Prussian System of Electric Train Lighting. Herr Carl Roderbourg. Describes the system of electric lighting adopted. 2500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65304 D.

**Train Pipes.**

To Detect Fall of Pressure and Stoppages in Train Pipes. Thomas J. Quirk. An illustrated description of an air-brake mechanism intended to prevent loss of pressure from any cause. 1000 w. Loc Engng—Sept., 1904. No. 64800 C.

**Trucks.**

Flange Wear and Side Bearing Trucks. Gustav Lindenthal. Read before the N. Y. R. R. Club. Also editorial. An investigation of the wear of wheel flanges and of the inside flange of the outside rail of curves and the remedy. Ills. 5700 w. Eng News—Sept. 22, 1904. No. 65092.

## NEW PROJECTS.

**Alaska.**

A Year's Work on the Alaska Central Railway. A. W. Swanitz. An illustrated account of this project and the progress made. 1200 w. Eng News—Sept. 8, 1904. No. 64910.

**Spain.**

Trans-Pyrenean Railways. Outlines schemes for constructing three lines, two of which will include long international tunnels. Map. 700 w. Engng—Sept. 9, 1904. No. 65037 A.

## PERMANENT WAY AND BUILDINGS.

**China.**

The Railways of Southern China (Eisenbahnen in Südchina). N. Post. A review of the development of railway construction in the vicinity of Canton, with maps. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 9, 1904. No. 65152 D.

**Grades.**

Grade Reduction, Omaha and Springfield Divisions, Illinois Central R. R. J. C. Gray. Notes on the best practice in grade reduction, with illustrations of work. 1300 w. Ry & Engng Rev—Aug. 27, 1904. No. 64728.

**Interlocking.**

Electric Interlocking of Switches and Signals at Antwerp Central Station. L. Weissenbruch. A review of the development of mechanically operated switches, the various systems, with illustrated detailed description of this installation and much information of interest. 26300 w. Bul Int Ry Cong—Aug., 1904. No. 65078 F.

**Profile.**

The Railway Profile Considered with Reference to Propelling Power. Prof. William D. Pence. Condensed from a paper read before the Indiana Engng. Soc. Calls attention to fundamentals connected with the operation of locomotives and trains needed to be understood by the civil engineer having charge of line construction. 1600 w. Eng Rec—Sept. 10, 1904. No. 64937.

**Rails.**

Effects of Annealing on Steel Rails. Thomas Andrews and Charles Reginald Andrews. Gives results of experiments showing the effects produced by annealing and also some indication of the physical effects produced by treating steel rails when shipping them in connection with various permanent way arrangements. 4200 w. Am Mfr & Ir Wld—Sept. 22, 1904. No. 65098.

**Reconstruction.**

Rebuilding a Great Railroad. Frank H. Spearman. An account of reconstruction work, introducing novel methods, straightening tracks, rebuilding bridges, etc. 2500 w. World's Work—Oct., 1904. No. 65256 C.

**Shops.**

The Sedalia Shops of the Missouri Pacific. Illustrated detailed description of shops under construction. 1500 w. Ry Age—Sept. 23, 1904. No. 65235.

**Signal Batteries.**

Signal Batteries in Summer. H. S. Balliet. Discusses troubles due to the ex-

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pansion of porcelain and glass and the evaporation of solutions. 1000 w. R R Gaz—Vol. XXXVII. No. 12. No. 64777.

**Signaling.**

Railroad Signaling. G. E. Ellis. Discusses the general principles of railroad signaling and types used. Ills. 9000 w. Jour W Soc of Engrs—Aug., 1904. No. 65094 D.

**Signals.**

A New System for the Protection of Trains by Engine-Cab Signals. Emile Guarini. Illustrates and describes a device invented by MM. Pfirmann and Wendorf, which gives an audible signal in the cab. It requires a third rail. 1000 w. Sci Am Sup—Sept. 24, 1904. No. 65086.

Lightning and Automatic Block Signals. H. S. Balliet. Describes interruptions due to lightning, considering their origin and the methods employed to control such troubles. 1500 w. R R Gaz—Vol. XXXVII. No. 13. Serial. 1st part. No. 64915.

The Electric Lighting of Railway Signals (Elektrische Beleuchtung von Eisenbahnsignalen). A. Frey. Describing the system of incandescent lamps used with the signal system on the St. Gothard Railway, in Switzerland. 2000 w. Elektrotech Zeitschr—Aug. 11, 1904. No. 65180 B.

**Slip.**

Draining and Steadying Slips. Illustrates and describes the treatment of such troubles by British engineers. 700 w. R R Gaz—Vol. XXXVII. No. 13. No. 64914.

**Special Tools.**

Special Tools in the Elkhart Shops of the L. S. & M. S. Ry. Illustrated descriptions of a number of interesting special appliances to facilitate the progress of work. 2500 w. Ry Mas Mach—Sept., 1904. No. 64929.

**Terminals.**

New York Terminal Station of the Pennsylvania. Illustrations from photographs of the model at the St. Louis Exposition, with explanatory notes. 400 w. R R Gaz—Sept. 23, 1904. No. 65211.

**Ties.**

Further Use of Steel and Reinforced Concrete Ties. Information regarding recent experiments made with ties other than wood. Also editorial. 4000 w. Ry & Engng Rev—Sept. 10, 1904. No. 64925.

Report on the Question of Wooden Sleepers or Crossties (Subject I. B. for Discussion at the Seventh Session of the Railway Congress). F. J. E. Spring. A study of the causes of deterioration of wooden sleepers in tropical climates and of the method of preventing it. 23800 w. Bul Int Ry Cong—Aug., 1904. No. 65079 F.

Wooden Ties: Selection of Kinds and Processes of Preservation. M. Housser. Report to be presented at the meeting of the International Railway Congress. On the kinds of wood used, various methods of treatment, deterioration, influence of ballast and subgrade, etc. 8000 w. Ry Age—Sept. 9, 1904. No. 64901.

**Tracks.**

Needed Improvements in Railway Track and Maintenance of Way. Editorial comparing briefly European and American railways to the disadvantage of the latter in the matter of tracks, with remarks on the exhibits at St. Louis. 1800 w. Eng News—Sept. 8, 1904. No. 64912.

**Turnouts.**

A Problem in Locating Turnouts. C. M. Kurtz. States the problem and gives ready and accurate methods of obtaining solutions. 800 w. Eng News—Sept. 8, 1904. No. 64913.

**Wash-Outs.**

Destructive Western Torrents. Illustrates and describes some destructive effects in New Mexico, Arizona, southern California and Nevada, especially on the Atchison, Topeka & Santa Fé. 1000 w. Ry Age—Sept. 9, 1904. No. 64898.

## TRAFFIC.

**England.**

Railway Traffic. A review of the Board of Trade returns and the effect of tramway traffic. Refers to the problem of classes to be solved in England and gives information of interest. 3300 w. Engng—Sept. 16, 1904. No. 65247 A.

**Fast Freight.**

Handling Fast Freight on the Canadian Pacific. Gives forms and information concerning the new method of handling fast freight on through trains, known as the "Red Card" system. 2200 w. R R Gaz—Sept. 23, 1904. No. 65210.

**Pooling.**

Report No. 2 on the Question of Pooling Locomotives (Subject VI. for Discussion at the Seventh Session of the Railway Congress). G. W. Rhodes. On the use of two or more crews; the advantages and disadvantages of the practice and the result of such common use with respect to the efficiency and the care of the locomotive. 6700 w. Bul Inst Ry Cong—Aug., 1904. No. 65080 F.

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### MISCELLANY.

**Exposition.**

The Exhibit of the "Big Four Route" at the St. Louis Exhibition. H. W. Hanbury. Illustration, with description of the locomotive shown and of the turntable on which it stands. 1200 w. Engng—Sept. 9, 1904. Serial. 1st part. No. 65035 A.

The Transportation Exhibits at the St. Louis Exposition (Das Eisenbahnverkehrswesen auf der Weltausstellung in St. Louis, 1904). Fr. Gutbrod. A review of the railway exhibits at St. Louis, the first portion describing the locomotive testing plant of the Pennsylvania Railroad. Serial. Part I. 6000 w. Zeitschr d Ver Deutscher Ing—Sept. 3, 1904. No. 65110 D.

**Jubilee.**

Jubilee on the Northeastern Railway. W. B. Paley. Outlines the history of this English road which has just completed its first half century. 2000 w. R R Gaz—Vol. XXXVII. No. 12. No. 64775.

**Norway.**

The Northernmost Railway of the Earth (Die Nördlichste Eisenbahn der Erde). F. Thiess. An account of the railway from Lulea to Narvik, opening up the iron ore deposits of northern Norway, and its proposed connection with the railway system of Finland. 2000 w. Glasers Annalen—Sept. 15, 1904. No. 65148 D.

**Reorganization.**

The New Engineering Organization on the Rock Island System. An explanation of the present organization which places the engineering force in a position of much greater responsibility. 1700 w. Eng Rec—Sept. 3, 1904. No. 64816.

## STREET AND ELECTRIC RAILWAYS

### STREET AND ELECTRIC RAILWAYS.

**Berlin.**

Precautionary Measures on the Berlin Overhead and Underground Railway. Mr. Bork, in the *Zeitung des Vereins.* A comparison with the Paris Metropolitan Railway. 3150 w. Bul Int Ry Cong—Aug., 1904. No. 65081 F.

**Boosters.**

The Booster Machine in Traction Service and Its Proper Regulation. Prof. Dr. Rasch. A discussion showing that the most suitable regulation of the buffer machine is to be effected by means of speed regulation. 3000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65310 D.

**Cars.**

Maintenances of Electric Cars and Their Equipment. H. A. Benedict. Read before the Utica convention. Discusses some of the problems in the operation of cars in large cities. 1700 w. St Ry Jour—Sept.. 24, 1904. No. 65221 C.

Relative Economy in the Operation of Long and Short Cars. W. J. Davis, Jr. Read before the Utica convention. A discussion of power consumption of cars of various sizes and weights and relative cost of operation as applying to cities of 30,000 to 50,000 inhabitants. 1400 w. St Ry Jour—Sept. 24, 1904. No. 65218 C.

**Combined System.**

A System of Electric Driving, Especially for Electric Tramways. (Betriebssystem für Elektrische Kraftanbagen insbesondere für Bahnen.) Dr. Johann Sanulka. A description of an electro-pneumatic system of power transmission, especially adapted for use with single-phase motors. 2500 w. Zeitschr f Elektrotechnik—Sept. 4, 1904. No. 65170 D.

**Control.**

Raworths' Automatic Regenerative Control. An illustrated description of this system, the apparatus and report of trials made. 3200 w. Tram & Ry Wld—Sept. 8, 1904. No. 65214 B.

**Electric Railways.**

The History and Development of Electric Railways. Frank J. Sprague. An interesting historical review. 8500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65269 D.

**Electric Traction.**

Alternating vs. Direct Current Traction. Prof. Dr. F. Niethammer. A comparison of the various electric systems with regard to first cost, operating expenses, reliability and safety in service. Ills. 14500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65267 D.

Some Early Work in Polyphase and Single-Phase Electric Traction. Bion J. Arnold. An illustrated description of the conditions surrounding the development and application of the alternating current system, with details making clear its operation. 7500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65266 D.

**Equipment.**

Notes on Equipment of the Wilkes-Barre & Hazleton Railway. Describes novel features, particularly the covered third rail and the special form of collect-

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ing shoe employed. Ills. 4000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65268 D.

**Fire Test.**

Car House Fire Test in Cleveland. Illustrated description of a remarkable and successful test of a fire-extinguisher outfit designed for the protection of car houses. 2000 w. St Ry Jour—Sept. 10, 1904. No. 64897 C.

**Germany.**

Costs and Profits of Electric Railways in Germany. Interesting statistics on the financial results which have followed the change from horse to electrical traction in this country. 2000 w. U S Cons Repts—July, 1904. No. 64743 D.

**Heavy Traffic.**

High-Speed Electric Railways for Freight and Passengers. R. W. Scott. A description of the Wilkes-Barre and Hazleton Railway and the Lackawanna and Wyoming Valley Railroad, being electric railways for heavy traffic in the anthracite coal region of Pennsylvania. 3500 w. Engng Mag—Oct., 1904. No. 65194 B.

**Interurban.**

The Dayton, Covington & Piqua Traction Company. Illustrated description of a successful electric railway in Ohio, carrying passengers and freight. 4500 w. St Ry Jour—Sept. 17, 1904. No. 65009 C.

The Future of Interurban Electric Railways. Ernest Gonzenbach. A discussion of the things necessary for the success of a road, the present conditions and the future prospects. 3000 w. R R Gaz—Vol. XXXVII. No. 12. No. 64776.

The Indiana Northern Traction Company. Illustrates and describes an important interurban connection of 20 miles between Wabash and Marion. 1700 w. St Ry Jour—Sept. 10, 1904. No. 64896 C.

**Liverpool.**

The Tramway System of Liverpool. An illustrated detailed description of this very successful system, with historical notes and general information. 11500 w. Tram & Ry Wld—Sept. 8, 1904. No. 65212 B.

**Main Line.**

The New Haven's Electrification Plans in the Bronx. An account of improvements to be made on the New York, New Haven & Hartford between the Harlem River and New Rochelle. 1000 w. R R Gaz—Vol. XXXVII. No. 12. No. 64779.

**Merchandise.**

A Method of Handling Interurban Express Matter. George Dunford. Read before the Utica convention. Gives the forms and methods used in transacting business by the Utica & Mohawk Valley Electric Express. 800 w. St Ry Jour—Sept. 24, 1904. No. 65216 C.

Freight and Express Business on Street Railways. C. R. Van Etten. Read before the Utica convention. Discusses some of the things to be considered to determine whether a street railway can profitably engage in the transportation of freight and express. 1700 w. St Ry Jour—Sept. 24, 1904. No. 65222 C.

The Question of Freight. L. W. Serrell. Read before the Utica convention. Discusses the freight business on electric roads, the methods which would probably lead to a large increase in receipts, etc. 2000 w. St Ry Jour—Sept. 24, 1904. No. 65219 C.

**Modern Practice.**

Present Electric Railway Practice. Clarence Renshaw. Considers present practice in the generation of the electric power; in its transmission and distribution; and the operation of the cars. 3500 w. Pro Engrs' Soc of W Penn—July, 1904. No. 65054 D.

**Mont Blanc.**

The Mont Blanc Electric Railway (Le Tramway Electrique du Mont-Blanc). Lieut.-Col. G. Espitallier. An account of the proposed electric railway to the summit of Mont Blanc, with especial reference to the first section from Le Fayet to l'Aiguille du Goûter. 4000 w. 1 plate. Génie Civil—Sept. 3, 1904. No. 65119 D.

**New York.**

Early Transportation in New York. Henry E. Armstrong. An interesting review. 1500 w. R R Gaz—Vol. XXXVII. No. 14. No. 64999.

History and Physical Aspects of the New York Subway. Illustrated description; also short articles on the traffic features, signaling and power equipment. 4500 w. R R Gaz—Vol. XXXVII. No. 14. No. 65000.

Power Production and Distribution on the Metropolitan Street Railway System. M. G. Starrett. Read before the Utica convention. A description of the system which embraces all the street surface railway lines in the boroughs of Manhattan and the Bronx, New York. Also discussion. 8000 w. St Ry Jour—Sept. 24, 1904. No. 65215 C.

The Completion of the New York Subway. A brief review of this important engineering work with illustrations. 2000 w. Sci Am—Sept. 10, 1904. No. 64918.

The New York Subway. M. G. Cunniff. An illustrated description and review of the construction of this twenty-one-mile tunnel, built in about four years

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through a maze of pipes and sewers, under rivers, etc. 5000 w. Wld's Work—Oct., 1904. No. 65255 C.

The Rapid Transit Subway in New York City. An illustrated article reviewing this recently completed work and describing the general conditions. 3800 w. Elec Rev, N. Y.—Sept. 10, 1904. No. 64941.

**Power House.**

The Power House of the Interborough Rapid Transit Company, New York. Illustrated description of this plant and its equipment. 4500 w. Power—Sept., 1904. No. 64746 C.

**Rails.**

Rails and Joints. William H. Cole. Information based on tests and many years of experience, favoring the continuous rail. 2000 w. St Ry Jour—Sept. 3, 1904. No. 64838 C.

**Records.**

Important New System of Car Equipment Records for the Brooklyn Elevated Railroads. An explanation of the details of the system adopted. 4700 w. St Ry Jour—Sept. 3, 1904. No. 64837 C.

**Repairing Works.**

The Car Repairing Works of Liverpool Corporation Tramways. Illustrated detailed description. 2000 w. Tram Ry Wld—Sept. 8, 1904. No. 65213 B.

**Shops.**

A New Concrete Paint and Overhauling Shop—Philadelphia Rapid Transit Company. Illustrated description of improvements made in shop facilities at the Kensington avenue shops, especially the reinforced concrete construction and other interesting details. 4800 w. St Ry Jour—Sept. 3, 1904. No. 64836 C.

**Signaling.**

Block Signaling of Electric Railways with Track Circuit Control. J. B. Struble. Read before the Utica convention. Describes arrangements of alternating current track circuits for electric roads. 1000 w. St Ry Jour—Sept. 24, 1904. No. 65220 C.

**Single-Phase.**

Transmission and Distributing Problems Peculiar to the Single-Phase Railway. Paul M. Lincoln. Discusses maximum economy, voltage drop, insurance against accident, mechanical considerations and avoidance of undue multiplicity of stations. 2400 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65315 D.

**Storage Batteries.**

The Use of Storage Batteries in Long Distance Railway Work. W. N. Stewart. Urging the use of the Edison battery for this work. 1600 w. Elec Rev, Lond—Sept. 9, 1904. No. 65029 A.

**Toulon.**

The Electric Tramways of Toulon. (Les Tramways Electriques de Toulon.) P. Cafourier. With map of the line's views in the power house and a general account of the equipment. 2000 w. Génie Civil—Aug. 20, 1904. No. 65116 D.

**Trail Cars.**

The Desirability of Trail Cars in City Electric Railway Service. M. G. Pavie. Abstract of report prepared for the Vienna meeting of the International Street Railway and Light Railway Association. The opinions of different companies on the use of trail cars, with comments by the writer. 1700 w. St Ry Jour—Sept. 17, 1904. No. 65010 C.

**Tramway Tariffs.**

Tramway Tariffs on the Continent. Francis Reverdin. Reviews the subject as dealt with in Switzerland, Germany, Italy and Belgium at various places. 10200 w. Trac & Trans—Sept., 1904. No. 64970 E.

**Trolley.**

A Trolley for Heavy Multiple Unit Electric Trains. Herbert I. Bennett. An illustrated description of the roller trolley used on the San Francisco, Oakland and San José Railway. 600 w. Sci Am—Sept. 17, 1904. No. 64984.

**Trolley Curves.**

Trolley Wire Curves for Electric Tramways. (Die Kurvenabspannung des Fahrdrahtes bei Elektrischen Strassenbahnen mit Rollenkontakt.) R. Wahle. An exhaustive discussion of the arrangement of overhead trolley wires on curves to permit satisfactory action of the contact roller. 7500 w. Elektrotech Zeitschr—Sept. 1, 1904. No. 65159 B.

**Tyneside.**

The Use of Electricity on the Northeastern Railway and Upon Tyneside. Charles H. Merz and William McLellan. Read before the British Assn. A short account of the most recent development in the use of electricity on Tyneside, indicating some of the main principles governing the cheap generation and distribution of electricity for industrial purposes. Ills. 2500 w. Engr, Lond.—Sept. 9, 1904. No. 65044 A.

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## EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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## THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Cement. *b.-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.

Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Engineering Times. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Public Works. *m.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-w.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.